United States Court of Appeals
for the
District of Columbia Circuit

TRANSCRIPT OF RECORD

FOR MR. CHIEF JUSTICE MARTIN

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TRANSCRIPT OF RECORD

United States Court of Appeals for the District of Columbia

APRIL TERM, 1934

No. 6278

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METROPOLITAN ENGINEERING COMPANY,
APPELLANT,

vs.

CONWAY P. COE, COMMISSIONER OF PATENTS.

APPEAL FROM THE SUPREME COURT OF THE DISTRICT OF COLUMBIA.

FILED AUGUST 4, 1934.

PRINTED SEPTEMBER 20, 1934.

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United States Court of Appeals for the District of Columbia

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METROPOLITAN ENGINEERING COMPANY,
APPELLANT,

vs.

CONWAY P. COE, COMMISSIONER OF PATENTS,
APPELLEE.

APPEAL FROM THE SUPREME COURT OF THE DISTRICT OF COLUMBIA.

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JUDD & DETWEILER (INC.), PRINTERS, WASHINGTON, D. C., SEPTEMBER 4, 1934.

United States Court of Appeals for the District of Columbia

No. 6278.

METROPOLITAN ENGINEERING COMPANY, Appellant,
vs.
CONWAY P. COE, Commissioner of Patents.

---

a Supreme Court of the District of Columbia.
In Equity.
No. 51977.

METROPOLITAN ENGINEERING COMPANY, Plaintiff,
vs.
THOMAS E. ROBERTSON, Commissioner of Patents,
Defendant.

UNITED STATES OF AMERICA,
District of Columbia, ss:

Be it remembered, That in the Supreme Court of the District of Columbia, at the City of Washington, in said District, at the times hereinafter mentioned, the following papers were filed and proceedings had, in the above-entitled cause, to wit:

1 *Bill of Complaint to Enforce Issuance of Patent.*

Filed October 10, 1930.

In the Supreme Court of the District of Columbia.

In Equity.
No. 51977.

METROPOLITAN ENGINEERING COMPANY, Plaintiff,
vs.
THOMAS E. ROBERTSON, Commissioner of Patents,
Defendant.

To the Supreme Court of the District of Columbia:

The plaintiff states as follows:

I. The plaintiff, Metropolitan Engineering Company, is a corporation of the State of New York, and brings this suit as assignee of Thomas E. Murray, deceased.

II. The defendant, Thomas E. Robertson, is the Commissioner of Patents of the United States (whose official residence is in Washington, in the District of Columbia), and is sued as the Commissioner of Patents of the United States.

III. This bill is filed under and in accordance with the provisions of Section 4915 of the Revised Statutes of the United States, as amended (44 Stat. L., 1335).

IV. Thomas E. Murray, on the 31st day of May, 1923, filed in the United States Patent Office an application for a patent for certain improvements in Boilers, under and in accordance with the Statutes of the United States and the Rules of Practice of the United States Patent Office in such cases made and provided, which application was given Serial No. 642,427.

V. The said application was duly prosecuted under and in compliance with the said Statutes and Rules and was passed upon by the Primary Examiner who allowed
2 a number of the claims thereof, but finally rejected
and refused claim 19 and claims 21 to 27, inclusive, thereof, reading as follows:

"19. A steam generator including in combination approximately horizontal water tubes heated by convection and a furnace having a combustion chamber below said over head tubes, a wall of said combustion chamber being composed of substantially upright tubes connected into the circulation of the generator, said tubes being spaced apart a distance not substantially greater than their diameter, and metal extensions from said tubes united thereto with good heat conducting joints and practically closing the spaces between them so that only the tubes and extensions are exposed to the heat of the burning fuel and the two together constitute the wall heated only on its inner face, the outer surface of such wall being covered with a sheathing of insulating material united to and supported by said wall.

"21. A steam generator including in combination approximately horizontal water tubes heated by convection and a furnace having a combustion chamber below said over head tubes, a wall of said combustion chamber being composed of substantially upright tubes connected into the circulation of the generator, said tubes being spaced apart a distance not substantially greater than their diameter,

exposed to the heat of the burning fuel and the two constitute a wall heated only on its inner face, the outer face of said wall being covered with insulating material.

"25. A steam generator including in combination water tubes heated by convection and a furnace having a combustion chamber adjacent to said tubes, a wall of said combustion chamber being composed of tubes connected into the circulation of the generator, said tubes being spaced apart a distance not substantially greater than their diameter, and metal extensions from said tubes attached thereto with good heat conducting joints and practically closing the spaces between them, and providing an increased area exposed to the radiant heat of the burning fuel and conducting such heat to the tubes, each of said extensions being limited in width as a maximum to the diameter of the tubes, the tubes and extensions constituting a substantially closed wall exposed on the inner face only to the combustion gases, the outer surface of said wall being covered with a sheathing of insulating material attached to and supported by said walls.

"26. A steam generator including in combination water tubes heated by convection and a furnace having a combustion chamber adjacent to said tubes, all the walls of said combustion chamber being composed of tubes connected into the circulation of the generator and exposed to the heating gases of the inner side of said rows of tubes, the outer surface of said walls being covered with a sheathing of insulating material attached to and supported by said walls.

"27. A steam generator including in combination water tubes heated by convection and a furnace having a combustion chamber, a wall of said chamber being composed of water tubes connected into the circulation of the generator, said tubes being spaced close together so as to approximately close the opening between adjacent tubes and the wall heated on its inner face only, the outer surfaces of said wall being covered with a sheathing of insulating material attached to and supported by said wall."

VI. Subsequently to the filing of said application said Thomas E. Murray died and by his last will and testament the entire right, title and interest in and to said application Serial No. 642,427 became and was vested in Joseph Bradley Murray, Thomas E. Murray, Jr., and John F.

4 Murray, his executors under said will; that on the 16th day of September, 1929, letters testamentary were granted to said executors by the Surrogate Court of Kings County, New York, and that on the 22nd day of April, 1930, the said executors did, by an instrument in writing, assign and transfer to the plaintiff the entire right, title and interest in and to said application Serial No. 642,427, which said assignment was recorded in the United States Patent Office on the 24th day of April, 1930, in Liber S-143, p. 114, as by said assignment or a duly authenticated copy thereof here in Court to be produced will more fully and at large appear. And the entire right, title and interest in and to said application Serial No. 642,427 so conveyed now remains vested in the plaintiff.

VII. After said final rejection and refusal of said claims by the Primary Examiner, the said plaintiff appealed from the decision of said Primary Examiner to the Board of Appeals, who, on the 5th day of August, 1930, affirmed the decision of said Primary Examiner.

VIII. The grounds of rejection urged by the Primary Examiner and by the Board of Appeals against the allowance to the plaintiff of said rejected claim 19 and claims 21 to 27, inclusive, were

(1) the non-patentability of said claims in view of certain prior United States patents, to-wit:

743,271 to Griffiths, dated Nov. 3, 1903;
1,474,156 to McClellon, dated Nov. 13, 1923;
1,125,113 to Junkers, dated Jan. 19, 1915.

(2) and in view of certain alleged unproven prior practices of which the Board of Appeals undertook to take judicial notice.

IX. That in view of the said decision of the Board of
Appeals, the defendant, Thomas E. Robertson, Commis-
sioner of Patents, has refused and still refuses to
5 allow the said claim 19 and the said claims 21 to 27,
inclusive, of said application, which claims plaintiff
has insisted and still insists are allowable and patentable
to it.

X. That no appeal has been taken from the decision of said Board of Appeals *ot* the Court of Customs and Patent Appeals and no such appeal is pending or has been decided.

XI. The plaintiff further states that the said invention as expressed in said claim 19 and said claims 21 to 27, inclusive, of said application is new and useful and was not known or used by others in this country before the invention thereof by the said Thomas E. Murray, and was not patented or described in any printed publication in this or any foreign country before said Murray's invention thereof or more than two years prior to said Murray's application for patent therefor in this country, and was not in public use or on sale in this country for more than two years prior to said Murray's application, and was not patented in any foreign country by said Murray or his legal representatives or assigns on an application filed more than twelve months prior to said Murray's application in this country, and was not abandoned.

XII. Wherefore, the plaintiff prays that this Honorable Court shall revise and reverse the decision of the Board of Appeals and of the said defendant, Thomas E. Robertson, Commissioner of Patents; shall adjudge that the plaintiff is entitled, according to law, to receive a patent for the invention specified in said claim 19 and claims 21 to 27, inclusive, of said application; and shall authorize the said defendant, Thomas E. Robertson, to issue a patent to the plaintiff containing said claims on the filing in the Patent Office of a copy of this Court's adjudication and otherwise complying with the requirements of law; and for such other and further relief in the premises as the nature of
6 the case may require and to this Honorable Court shall seem meet.

METROPOLITAN ENGINEERING
COMPANY,
By THOMAS E. MURRAY, Jr.,
President.

MELVILLE CHURCH,
Attorney and Counsel for Plaintiff.
D. ANTHONY USINA,
Of Counsel.

STATE OF NEW YORK,
County of Kings, ss:

On this 8th day of October, 1930, personally appeared before me the above named Thomas E. Murray, Jr., the President of the plaintiff corporation named in the foregoing bill of complaint and, being duly sworn, did depose and say that he has read the said bill by him subscribed and knows the contents thereof and that the same is true to the best of his knowledge and belief.

[SEAL.] STEPHEN S. McCARTHY,
Notary Public.

Notary Public Kings Co. No. 186 Reg. No. 1082.
Cert. filed in N. Y. Co. No. 211 Reg No. 1-Mc-150.
Commission expires March 30th, 1931.

Answer to Bill of Complaint.

Filed October 30, 1930.

* * * * * * *

To the Honorable the Judges of the Supreme Court of the District of Columbia:

I. Defendant answering the Bill of Complaint admits for the purpose of this suit the allegations of paragraph I.

7 II. Defendant admits the allegations of paragraph II.

III. Defendant admits that jurisdiction is conferred by Section 4915 R. S. as amended March 2, 1927 (35 U. S. C. A. 63).

IV. Defendant admits the allegations of paragraph IV with reference to the application of Thomas E. Murray, Serial No. 642,427, filed May 31, 1923.

V. Defendant admits the allegations of paragraph V, in which claims 19 and 21 to 27, inclusive, are recited. Defendant is informed and believes and therefore avers that the said claims are not patentable to plaintiff over the following prior art:

Breen, 590,962, Oct. 5, 1897;
Griffiths, 743,271, Nov. 3, 1903;
Junkers, 1,125,113, Jan. 19, 1915;
McClellon, 1,474,156, Nov. 13, 1923.

and in view of the common practice of covering boilers with an asbestos covering. Profert of copies of said patents is hereby made.

VI. Defendant admits the allegations of paragraph VI.

VII. Defendant admits the allegations of paragraph VII.

VIII. Defendant admits the allegations of paragraph VIII.

IX. Defendant admits the allegations of paragraph IX.

X. Defendant admits the allegations of paragraph X.

XI. Defendant denies that the said claims 19 and 21 to 27, inclusive, are patentable to plaintiff in view of the prior art and practice set forth in paragraph V, as more fully appears from the Examiner's Statement and the decision of the Board of Appeals, profert of which is hereby made.

And further answering defendant denies each and every allegation of the Bill of Complaint not herein specifically and sufficiently denied or admitted, and prays that plaintiff's Bill of Complaint be dismissed.

8 Wherefore defendant having fully answered the Bill of Complaint denies that plaintiff is entitled to the relief demanded or any part thereof and prays that he be hence dismissed with all costs and expenses of the proceedings against the plaintiff.

THOMAS E. ROBERTSON,
Commissioner of Patents,
Defendant.

T. A. HOSTETLER,
Solicitor of the U. S. Patent Office,
Attorney for Defendant.

DISTRICT OF COLUMBIA,
City of Washington, ss:

I, Thomas E. Robertson, Commissioner of Patents, depose and say that I have read the above answer by me subscribed and know the contents thereof, and that the statements of facts therein made as upon personal knowledge are true, and those made upon information and belief I believe to be true.

THOMAS E. ROBERTSON,
Commissioner of Patents.

Subscribed and sworn to before me this 29th day of October, 1930.

[SEAL.] FANNIE W. SCHRIDER,
Notary Public, D. C.

My commission expires May 12, 1933.

9 *Order Substituting Defendant.*

Filed September 22, 1933.

* * * * * * *

Upon consideration of the motion filed by plaintiff herein, it is hereby ordered this 22nd day of September, 1933, that the Honorable Conway P. Coe, Commissioner of Patents, be substituted as defendant for the Honorable Thomas E. Robertson, formerly Commissioner of Patents.

ALFRED A. WHEAT,
Chief Justice.

10 *Findings of Fact.*

Filed April 9, 1934 as of March 27, 1934.

* * * * * * *

1. Plaintiff's application discloses a water tube boiler having tubes heated by convection as distinguished from radiation, the water tubes forming the walls of the combustion chamber being connected with overlapping fins or metal members, and the outer sides of the wall being covered with insulating material.

2. The patent to Griffith, 743,271, discloses water tubes heated by convection and connected to headers in a circulating system, the tubes being placed in such close relation as to form walls for the combustion chamber. An asbestos covering is provided.

3. The McClellon patent, 1,474,156, discloses a fire box formed of tubes spaced apart and connected by filler strips welded to the tubes. The outer wall is covered with asbestos.

4. The patent to Junkers, 1,125,113, discloses a water tube combustion chamber, the tubes being spaced apart and connected by fins or webs that fill the space between the water tubes. 11

5. Defendant's brief admits Claim 24 to be patentable.

Conclusions of Law.

1. Claims 19, 21, 22, 23, 25 and 26 are unpatentable over the prior patents adduced by defendant.

2. The Griffith patent discloses the general combination claimed in the above mentioned claims except for the particular type of fire box construction, which type is shown to be old by McClellon and by Junkers.

3. Plaintiff is not entitled to an allowance of Claims 19, 21, 22, 23, 25 and 26. The Bill will be dismissed as to these claims and granted as to Claim 24.

JENNINGS BAILEY,
Justice.

March 27th, 1934.

12 *Final Decree.*

Filed April 23, 1934.

* * * * * * *

This cause having come on to be heard, and having been tried in open court and argued by counsel for the respective parties upon the pleadings and proofs adduced, and submitted to the Court, upon consideration thereof,

It is hereby adjudged, ordered and decreed this 23rd day of April, 1934:

1. That the plaintiff is entitled, according to law, to receive Letters Patent on its application, Serial No. 642,427, filed May 31, 1923, for the invention of Thomas E. Murray, as specified in claim 24 of said application, to wit:

"24. A steam generator including in combination water tubes heated by convection and a furnace having a combustion chamber adjacent to said tubes, a wall of said combustion chamber being composed of water tubes connected into the circulation of the generator, said tubes being spaced apart a distance not substantially greater than their diameter, and metal extensions from said tubes attached thereto with good heat conducting joints and practically closing the space between them but being free to move separately, so that only the tubes and extensions are exposed to the heat of the burning fuel and the two 13 constitute a wall heated only on its inner face, the outer face of said wall being covered with insulating material."

and the Commissioner of Patents is hereby authorized to issue Letters Patent on said application containing said claim, in addition to any claims already allowed therein, on the plaintiff filing in the Patent Office a copy of this adjudication and otherwise complying with the requirements of law.

2. The bill of complaint is hereby dismissed as to claims 19, 21, 22, 23, 25, 26 and 27 of said application.

JENNINGS BAILEY,
Justice.

Approved as to form.
MELVILLE CHURCH,
Attorney for Plaintiff.
T. A. HOSTETLER,
Attorney for Defendant.

14 *Order Noting Appeal, Fixing Undertaking, &c.*

Filed May 9, 1934.

* * * * * * *

Now comes the plaintiff, Metropolitan Engineering Company, by Melville Church, its attorney of record, and notes in open court its appeal to the Court of Appeals of the District of Columbia from the final decree entered herein on April 23, 1934;

Whereupon, it is ordered that the plaintiff furnish a satisfactory undertaking as security for costs on said appeal in the sum of One Hundred ($100.00) Dollars, or, in lieu thereof, deposit Fifty ($50.00) Dollars in cash with the clerk of this Court.

JENNINGS BAILEY,
Justice.

Washington, D. C., May 9, 1934.

Memorandum.

May 9, 1934.—$50 deposited in lieu of undertaking on appeal.

15 *Assignment of Errors.*

Filed May 9, 1934.

* * * * * * *

Now comes the plaintiff, in the above-entitled cause, and files the following assignment of errors upon which it will rely upon the prosecution of its appeal from the decree of this honorable Court, entered on the 23rd day of April, 1934:

(1) The Court erred in dismissing the bill of complaint as to claims 19, 21, 22, 23, 25, 26 and 27 of the application for Letters Patent of Thomas E. Murray, Serial No. 642,427, filed May 31, 1923.

(2) The Court erred in not entering a decree adjudging that the plaintiff is entitled, according to law, to receive Letters Patent on its application, Serial No. 642,427, filed May 31, 1923, for the invention of Thomas E. Murray, as specified in claims 19, 21, 22, 23, 25, 26 and 27 of said **application.**

16 (3) The Court erred in holding that claims 19, 21, 22, 23, 25 and 26 are unpatentable over the prior patents adduced by the defendant.

(4) The Court erred in holding that the patent of Griffiths, No. 743,271, discloses the general combination claimed in the above-mentioned claims, except for the particular type of firebox construction, which type is shown to be old by the patent of McClellon, No. 1,474,156, and by the patent of Junkers, No. 1,125,113.

(5) The court erred in finding that the patent to Griffiths, No. 743,271, discloses water tubes heated by convection and connected to headers in a circulating system, the tubes being placed in such close relation as to form walls for the combustion chamber.

(6) The Court erred in not finding that the Murray application, Serial No. 642,427, discloses a boiler construction consisting of a steam drum, front headers connected thereto, rear headers also connected thereto, horizontal, inclined tubes extending between said headers and heated by convection from the fire, and a combustion chamber below said tubes, the walls of which are composed of a series of spaced vertical tubes extending between bottom headers, connected to receive water from the rear headers, and top headers connected to the steam drum, and metal extensions welded to the vertical tubes and filling the spaces between them, together with a sheathing of heat insulating material applied to the outer surfaces of, and supported by said walls.

17 (7) The Court erred in not finding that the invention specified in the rejected claims, Nos. 19, 21, 22, 23, 25, 26 and 27 of said application, comprises the combination of the convection tubes of a boiler or steam generator, connected with a steam drum so that a circulation of boiler water therethrough is established, and a combustion chamber having a wall composed of tubes connected into the circulation of the generator, and a sheathing of insulating material applied to the outer surface of and supported by the walls, and that certain of the more specific claims define the combustion chamber wall as composed of tubes connected into the circulation of the generator and metal extensions from the tubes, attached thereto by good heat conducting joints, and closing the spaces between them.

(8) The Court erred in not finding that, at the time Mr. Murray conceived this invention, the most approved practice in the design of power plant boilers was to construct the combustion chamber walls of fire brick or refractory material, and that this was a factor limiting the steam output of the boiler, because, if the fire was forced in order to make more steam in the boiler, the high temperature existing in the combustion chamber soon destroyed the walls, causing excessive maintenance cost and making it necessary to take the boiler out of commission for several weeks while the walls were being repaired or replaced, which conditions made it imperative to keep the steam output of the boiler below two hundred and fifty per cent (250%) of its rated capacity.

18 (9) The Court erred in not finding that the Murray application, Serial No. 642,427, was based upon Mr. Murray's preliminary studies and sketches outlining his idea of the construction which would avoid these difficulties and eliminate the excessive maintenance cost for the furnace walls.

(10) The Court erred in not finding that, soon after Mr. Murray made these preliminary studies in March, 1923, he submitted them to a number of engineers particularly skilled in this art, for their comment, but said engineers did not approve of the improvements suggested and expressed the opinion that the tubes in the side walls would not stand up under the heat, and, further, that the use of these water walls would reduce the temperature in the combustion chamber so much as to interfere with combustion of the fuel.

(11) The Court erred in not finding that the Murray invention, as outlined in the preliminary studies and sketches, and disclosed in the Murray application, Serial No. 642,427, was first physically embodied in boilers Nos. 51, 52 and 53, at Hell Gate Station, erected under Mr. Murray's supervision, for United Electric Light & Power Company, in the latter part of 1923, and the early part of 1924.

(12) The Court erred in not finding that the construction embodied in such boilers at Hell Gate Station was operated with great success and that it proved to be possible to force these boilers up to five hundred and twenty per cent (520%) of their rated capacity, thus doubling the

19 steam output without any deterioration or destructive effect upon the combustion chamber walls, while

the cost of maintaining the furnace walls was cut from Ten Thousand Dollars ($10,000.00) per furnace per year to about One Hundred Dollars ($100.00).

(13) The Court erred in not finding that the furnace construction embodied in such Hell Gate boilers attracted great attention in the profession and that numerous articles appeared in trade journals throughout the world, describing this construction as an inventive contribution advancing the art, and giving credit therefor to Thomas E. Murray.

(14) The Court erred in not finding that soon after the erection of these Hell Gate boilers and their successful operation, a license agreement was executed between Thomas E. Murray and International Combustion Engineering Corporation, by which that company secured the exclusive license to construct boilers having furnace walls embodying said Murray invention, that this license agreement was canceled in November, 1929, because of the default of the licensee in the payment of royalties thereunder, but that the licensee paid the plaintiff about Three Hundred and Fifty Thousand Dollars ($350,000.00) in royalties for the exclusive right to use this Murray invention, during the period that the license remained in force and effect, and under this license boiler installations were constructed and erected in all parts of the world having a total rated capacity of about six hundred thousand horse power.

20 (15) The Court erred in not finding that the Murray invention has displaced the refractory, or fire brick furnace wall construction, which was the most approved practice at the time Mr. Murray conceived the invention, and has rendered the refractory wall for boiler furnaces obsolete.

(16) The Court erred in not finding that the Griffiths patent, No. 743,271, patented November 3, 1903, which was the basis for the refusal of the rejected claims, discloses a steam boiler which is wholly inoperative because the various tubes and pipes are so connected that, under the heat of the fire, the boiler water cannot circulate therethrough, with the result that the tubes will burn out and the boiler will blow up, and that the evidence does not show any way in which the illustrated construction of the Griffiths boiler can be changed or modified so as to make the boiler operative.

(17) The Court erred in not finding that the Griffiths boiler does not have any circulation and there are no tubes

in it which are connected into the circulation of the steam generator.

(18) The Court erred in not finding that the Griffiths patent does not anticipate the rejected claims and that the construction specified in said claims involves invention over said patent.

(19) The Court erred in not finding that the other patents in evidence are relied on by the defendant
21 merely to show details of construction, such as the welding of filler strips to tubes to close the spaces between them, and the application of a sheathing of heat insulating material, and that these patents do not disclose the combination of elements as specified by Murray in the rejected claims.

(20) The Court erred in not finding that the rejected claims, Nos. 19, 21, 22, 23, 25, 26 and 27, are for a novel combination of elements, which involved invention over the references in evidence.

Wherefore, plaintiff prays that the said decree may be revised and reversed as to claims 19, 21, 22, 23, 25, 26 and 27 of said Murray application.

MELVILLE CHURCH,
Attorney for Plaintiff.

Washington, D. C., May 9th, 1934.

Memoranda.

May 28, 1934.—Statement of Evidence and Stipulation filed.

May 29, 1934.—Statement of Evidence approved and filed.

22 *Stipulation and Designation of Record.*

Filed May 18, 1934.

* * * * * * *

The Clerk will please prepare and transmit to the Court of Appeals of the District of Columbia, as the record in the above-entitled cause, the following papers, which, it is stipulated, shall constitute the printed record on appeal:

I. Bill of Complaint.
II. Answer to the Bill of Complaint.

III. Condensed Statement of Evidence.

IV. Plaintiff's Exhibits, as follows:

(1) Drawing of Hell Gate Boilers, Nos. 11 to 43;

(2) Drawing showing construction of combustion chamber walls of Hell Gate Boilers 11 to 43;

(3A) to (3G), inclusive, eight original drawings of Thomas E. Murray;

23 (4) Drawing illustrating construction of Hell Gate Boilers, Nos. 51, 52 and 53;

(5) Photograph of interior of combustion chamber of one of Hell Gate Boilers, Nos. 51, 52 and 53;

(7) License Agreement of March 15, 1924, between Thomas E. Murray and International Combustion Engineering Corporation;

(8) Modifying agreement of March 8, 1926, between Thomas E. Murray and International Combustion Engineering Corporation;

(9) Tabulation of boiler installations under the License Agreement;

(12A) to (12C), inclusive, three photographs showing application of insulation to water wall at East River Station;

(13) Copy of specification, claims and drawings, as they now stand, and certain other papers, in Murray application, Serial No. 642,427;

(14) Chart illustrating principles of circulation;

(15) Diagram illustrating circulation of conventional water tube boilers;

(16) Diagram illustrating Murray water wall for combustion chamber with vertical tubes connected in the circulation of the boiler;

(17) Patents set up in Answer, including—

Breen, No. 590,962, Oct. 5, 1897;
Griffiths, No. 743,271, Nov. 3, 1903;
McClellon, No. 1,474,156, Nov. 13, 1923;
Junkers, No. 1,125,113, Jan. 19, 1915.

(18) Diagram illustrating absence of circulation in Griffiths boiler.

V. Findings of Fact and Conclusions of Law.

VI. Final Decree.

24 VII. Notation of Appeal and Order Fixing Amount of Appeal Bond.

VIII. Docket Entry showing cash deposit in lieu of Appeal Bond.

IX. Assignment of Errors.

X. This Stipulation and Designation of Record.

It is hereby stipulated and agreed that the following exhibits shall be transmitted to and considered by the Court of Appeals of the District of Columbia as physical exhibits, to wit:

Plaintiff's Exhibits Nos.:

(6) Model of Murray water wall construction;

(10) Collection of publications referring to Murray water wall construction;

(11) Book entitled "Steam, Its Generation and Use."

MELVILLE CHURCH,
Solicitor for Plaintiff.
T. A. HOSTETLER,
Solicitor for Defendant.

Washington, D. C., May 18, 1934.

25 Supreme Court of the District of Columbia.

UNITED STATES OF AMERICA,
District of Columbia, ss:

I, Frank E. Cunningham, Clerk of the Supreme Court of the District of Columbia, hereby certify the foregoing pages, numbered from 1 to 24, both inclusive, to be a true and correct transcript of the record, according to directions of counsel, herein filed, copy of which is made part of this transcript, in cause No. 51977 in Equity, wherein Metropolitan Engineering Company is Plaintiff and Thomas E. Robertson, Commissioner of Patents, is Defendant, as the same remains upon the files and of record in said Court.

In testimony whereof, I hereunto subscribe my name and affix the seal of said Court, at the City of Washington, in said District, this 3rd day of August, 1934.

[Seal Supreme Court of the District of Columbia.]

FRANK E. CUNNINGHAM,
Clerk.

26 In the Supreme Court of the District of Columbia.

In Equity.

METROPOLITAN ENGINEERING COMPANY, Plaintiff,

No. 51,977.

v.

CONWAY P. COE, Commissioner of Patents, Defendant.

Stipulation.

It is hereby stipulated by and between counsel for the respective parties to the above-entitled case that the following condensed statement of the evidence of the various witnesses upon the trial of said cause is true, complete and properly prepared, and that the annexed copies of Plaintiff's Exhibits 1 to 5, inclusive, 7 to 9, inclusive, and 12 to 18, inclusive, are true and correct copies of the original exhibits offered in evidence bearing such numbers.

C. B. DES JARDINS,
Of Counsel for Plaintiff.
T. A. HOSTETLER,
Counsel for Defendant.

Approved May 29th, 1934.
JENNINGS BAILEY,
Justice of the Supreme Court of the District of Columbia.

27 In the Supreme Court of the District of Columbia, Holding an Equity Court.

Equity. No. 51,977.

METROPOLITAN ENGINEERING COMPANY, Plaintiff,

vs.

CONWAY P. COE, Commissioner of Patents, Defendant.

Washington, D. C., Tuesday, March 13, 1934.

The above-entitled case came on for hearing before Mr. Justice Jennings Bailey at 10 o'clock a. m.

Appearances:

Melville Church, Esq., D. Anthony Usina, Esq., and C. B. Des Jardins, Esq., for the plaintiff.

T. A. Hostetler, Esq., for the defendant.

Proceedings.

Opening statements were made by Counsel for both parties. Whereupon John H. Lawrence was produced as a witness on behalf of the plaintiff, and having been first duly sworn, was examined and testified as follows:

Direct examination:

My name is John H. Lawrence. My age is 47. My residence is Bronxville, Westchester County, New York. My occupation at the present time is engineer to the receivers of the Interborough Rapid Transit Company.

I was graduated from Cornell University in 1909 with the degree of mechanical engineer. My course in college was directed mainly toward the study of power plant design.

28 After graduation I entered the employ of the New York Edison Company, New York City, which company operates large electrical power companies in that city. I was first employed as a draftsman, and at the end of seven or eight months became assistant to the mechanical engineer of the company.

I held that position for about three years.

The mechanical engineer was also associated with Thomas E. Murray as consulting engineer. Thomas E. Murray carried on engineering work for other interests around the country who were affiliated with the New York Edison Company.

That is the same Thomas E. Murray whose application is involved in this suit.

In 1913 the mechanical engineer was forced to leave on account of illness, and I became assistant mechanical engineer of the company. And I held that position until 1920.

My duties as assistant mechanical engineer consisted in handling details for the installation of mechanical equipment in the power plants of the Edison companies and the allied interests. I had charge of practically all of the work in the office along those lines. During that time we designed stations not only for the Edison company, but also for many power companies throughout the United States.

In 1920 I became vice-president and engineering manager for Thomas E. Murray, Incorporated. This was a company organized by Mr. Murray to carry on the work formerly carried on by his private organization, which was known as Thomas E. Murray, Consulting Engineer. In other words, it was incorporated. At that time Mr. Murray was also vice-president of the New York Edison Company and the other subsidiary companies of the New York Edison Company.

29 The Murray company was incorporated primarily to design a large power-generating station in New York City called the Hell Gate station.

The United Electric Light & Power Company, which was the operating company owning that property, did not have an engineering organization; and it was not the custom at that time for the operating company to design or to carry on engineering work for the other companies. So Mr. Murray was assigned the job of designing the Hell Gate station for the United Electric Light & Power Company.

Mr. Murray, while he was the president of the company, did not make his office with Thomas E. Murray, Incorporated; but was actively engaged as senior executive officer of the Edison company. His office was farther uptown in New York.

The station which we started on, as I said, was the Hell Gate station. Later on we also engaged in building stations for the Brooklyn Edison Company and the New York Edison Company.

Those three stations are among the three largest power stations in the whole world. In fact, I don't think there are more than a couple that are larger than those; and they are very little larger.

We also did work for a good many of the large industrial concerns around the country, such as the General Motors Company, Chrysler Motors, the Pressed Steel Car Company. Our work was of the general engineering character. But most of the work was on power plant development—either original design or revamping the stations.

The total cost of this power plant work which came under my supervision was over one hundred millions of dollars.

The work was entirely carried on by our organization from the original preliminary plans to the final completion of the station and the turning of the station over in
30 each case to the operating company. We secured the bids, made all the drawings, inspected the material

in the shops; and carried on all the work for the operating company.

This work continued until 1929. Since that time the work of the Murray Company has been mostly for industrial companies. There has been very little engineering work of any kind since 1929. There have been no new stations built to speak of for power companies since that time.

In 1929 Mr. Murray died, and shortly thereafter I was elected as president of the company; and continued in that position until January, 1933, when I became engineer for the receivers of the Interborough Rapid Transit Company.

When I became assistant to the mechanical engineer of the Edison Company in 1910, one of my duties was to keep informed on the development of steam power plant work all over the world; and I traveled around this country considerably either for the Edison Company or on my own spare time in order to study the development of power plants.

The mechanical engineer at that time was a man very much interested in the collection of information on power plants. And immediately after going with him it was necessary for me as part of my duties to read the various technical magazines from all over this country and all over the world. This was part of the regular work in the office, and I have always kept up that practice of following the various technical magazines.

I read a paper before the American Society of Mechanical Engineers; and for the past twenty years have taken part regularly in discussions of papers presented before that society.

I have been very active in that society for about twenty years. I have served on many of the most important com-
mittees. I served two years as vice president of the
31 association. I am also a member of the American
Institute of Electrical Engineers. I am a professional engineer in the State of New York, which qualification is necessary in order to practice engineering in the State of New York.

I will now explain and describe what was considered the most approved practice in the design of steam generating equipment for power plants as of the year 1922. (Referring to a book of exhibits and particularly to a drawing entitled "Diagram illustrating circulation of conventional horizontal water tube boiler"). The first drawing shown in this book is a drawing of the boilers installed in the Hell Gate Station of the United Electric Light & Power Company in 1921. These boilers represented the most modern practice in steam boilers as of that time.

The boiler unit consisted of the boiler or pressure parts, which consist of the steam drum, which is indicated in the upper right-hand corner, and the approximately horizontal steam generating tubes with their interconnecting pipes and headers.

The superheater, which is an integral part of a boiler unit, is located within the bank of approximately horizontal tubes. A superheater is a series of pipes in the boiler unit. The steam, after being generated in the horizontal tubes in this case, passes out of the drum, such as is shown there at the upper right-hand corner, to this series of pipe which is located within the boiler casing; and in those tubes the temperature of the steam is raised from the temperature at which it was generated in the steam generating tubes. Ordinarily the temperature of the steam is somewhere between 400 and 500 degrees Fahrenheit as it is made in the steam tubes. In the superheater the temperature of the steam is raised to anywhere from 600 to 750 in the plants in this country. There are a few plants where it may go up as high as 900. As a general thing, though, 750 degrees is about the maximum temperature used.

32 The large space in the center of this drawing is the combustion chamber.

At the lower part of that combustion chamber is the stoker equipment. In this case there was a stoker on each side of the combustion chamber. That represents where the fuel bed would be. The fuel is fed down through those spouts at each side of the boiler into the triangular shaped hopper, and from the hopper is fed into the stoker. The stoker is a mechanical means of shoveling coal into the combustion chamber.

On these units the combustion chamber walls were made entirely of refractory material—fire brick—which was the standard practice at that time; and the walls were built according to the very latest designs of furnace wall construction.

The water circulates in this drawing of the boilers 11 to 43 at Hell Gate station, as follows:

The feed water enters the drum of the boiler, which is shown at the upper right-hand corner—the steam drum of the boiler; and is sprayed into the space within that steam drum. The water flows from the steam drum down through the pipe below the drum into the headers marked "downcomer headers" at the right side of this drawing.

The tubes called "steam generating tubes," which are approximately horizontal, are heated by the gases coming from the combustion chamber, and the water flows toward the header at the left, marked "return header."

As the heat is imparted to those tubes, the water is not only heated, but steam is generated, causing a flow toward the left side.

The mixture of steam and water leaves the return headers at the top and passes through the return pipes or circulating tubes, as they are sometimes called, which are the horizontal tubes at the top of the boiler unit. These discharge into the steam drum, and the steam passes
33 out through the outlet at the top of the steam drum;
and the water returns through the cycle again down to the horizontal tubes.

The maximum velocity of circulation of the water in a boiler of this type is of the order of eight or ten feet a second. That would be about seven miles an hour.

The steam, when it passes out of the steam drum at the top, goes through the downcomer pipe, shown just to the right of the steam drum, and enters the superheater, which is the nest of tubes shown between the horizontal steam generating tubes. The superheated steam then leaves at the left-hand side of this unit, where the valve is shown.

The "feed water" is the water which is fed into the boiler to make up the loss due to the evaporation of some of the water into steam.

Circulation in a boiler is caused by the heat from the burning gases being imparted through the walls of the tubes into the water.

Heated water has a tendency to rise due to the fact that its density decreases; and, therefore, if we have a cold column on one side and a hot column on the other side, and they are connected together, the flow will be from the cold column to the hot column.

This velocity at times would be probably eight or ten feet per second, although it is very difficult to determine definitely just what the velocity is.

The rate of circulation in the steam drum is very much greater than the rate at which the feed water is introduced into the boiler, as the feed water only has to make up the loss due to some of the water being evaporated into steam, whereas the water which is in the boiler proper circulates around through the boiler tubes many times.

34 The temperature of the combustion chamber in the normal operation of a steam generator such as is shown in the drawing here was in the neighborhood of 2600 degrees Fahrenheit. That would be the average temperature in the furnace. There were points where the temperature was higher than that.

It was thought up to the time that this development was made that it was necessary to have an incandescent wall in a furnace of this type in order to get the proper combustion of the fuel.

The bubbles of steam make the column containing the bubbles lighter. In other words, the initial circulation is caused by the heating of the water; and then, as additional heat is added, steam is generated. The steam, being very much lighter than water, will make that part of the column lighter than it was when there was no steam present. The result is that we speed up the flow of the water due to the greater head that is available for causing circulation.

In steam generators such as I have described, the height at which the steam generating tubes were located above the fire or the fuel bed was due to the fact that there had been considerable trouble with the flame from the fuel bed impinging against the tubes and causing hot spots. In other words, the tubes became overheated at certain places and evidently blew up.

There was another reason for it. The gases, according to the theory at that time, did not have an opportunity to burn completely before they reached the horizontal generating tubes. By raising those tubes above the fuel bed, it gave the gases an opportunity to burn out completely.

In general those horizontal tubes are heated by convection. The bottom tubes receive some radiant heat from the fuel bed, but in general those tubes are heated by convection.

35 Heating by convection means the heating in the case of a boiler of the tubes and the water within the tubes by the flow of hot gases over the tubes.

Radiant heat is much more efficient than convection heat, as a square foot of surface will evaporate considerably more steam when exposed to the radiant heat of the furnace than when it receives merely the convection heat from the furnace.

Mr. DesJardins: I offer as plaintiff's exhibit number 1 the drawing of boilers 11 to 13 at the Hell Gate station, just explained by the witness. That is the first one in this book of exhibits.

(The drawing referred to was received in evidence and marked "Plaintiff's Exhibit 1.")

Referring to boilers such as shown in plaintiff's exhibit number 1, the walls around the combustion chamber of these units were built of refractory material, that is, fire brick. The walls being of considerable size, had to be designed especially to take care of expansion strains. This was accomplished by splitting the wall up into a number of sections and providing expansion joints.

The fire brick was of the very best quality, owing to the fact that these boilers had to be forced at higher ratings than the boilers in the older plants which we had had.

A common method of describing the capacity of a boiler is to say that a boiler had so much horsepower. A boiler is rated on the horsepower basis; and when it is operated at 100 per cent of rating, which is the normal rating, it means that each square foot of surface in that boiler, that is, the surface which is exposed to the heat of the furnace or the gases, must evaporate and does evaporate three and a half pounds per square foot per hour from and at 212 degrees. That is the standard rating. You generally speak of three and a half pounds as the amount of evaporation per square foot.

36 If this were the maximum amount of steam which could be developed from each square foot of surface in a boiler, it would be necessary to have many more boilers in a plant than are actually required, as the boilers are forced beyond 100 per cent of rating. In other words, each square foot of surface must generate more than three and a half pounds.

It was very rare at that time to have boilers operate over 200 per cent of rating, which was about seven pounds evaporation per square foot per hour. This required burning roughly two times the amount of coal required at a 100 per cent rating.

The more coal that is burned in the furnace, the higher the temperature of the furnace becomes unless you change something else in the control.

As a general rule, when you are forcing a boiler to a higher rating, you are increasing the temperatures very materially in the fire.

The second drawing in this booklet shows a plan of the furnace wall used on the boilers (Nos. 11 to 43) originally installed in the Hell Gate station. These walls were approximately eighteen inches to twenty-two inches thick.

Mr. DesJardins: I offer as plaintiff's exhibit 2 the drawing illustrating the construction of the combustion chamber walls in the Hell Gate boilers 11 to 43.

(The drawing referred to was received in evidence and marked "Plaintiff's Exhibit 2.")

This practice that I have described with reference to the construction of combustion chamber walls was the standard practice in every power plant of any size that I knew of anywhere in the world.

There are problems in the design and construction of steam generating equipment for power plant use that are not present in steam boilers for other uses.

37 Due to the size of the combustion space it is necessary to very carefully design the combustion chamber of a large power plant boiler. The amount of coal that is burned in the furnace is greater than it is in the small heating plants or small power plants. The temperature in the furnace is generally higher in the power station boiler than in the small power boiler, and certainly much higher than in a heating boiler; because the amount of coal which is burned per foot volume, cubic foot volume, is greater in the case of a power plant boiler. And, due to the size of the combustion chamber, there are strains set up in those walls which are not present in a small boiler.

In a power plant boiler you burn more coal per hour per square foot of heating surface because it is necessary to get the most out of a boiler unit that can be justified from the economic standpoint. In other words, it is a case of balancing investment against operating cost; and it is never justifiable to operate a boiler at 100 per cent of rating in power plants. You want to get the maximum that you can, depending upon the efficiency.

The effect of the high temperature in the combustion chamber is to reduce the strength of the refractory material. As the temperature of the fire brick increases, the strength decreases; and you may reach a point where the fire brick no longer has any strength. In fact, it may reach the point where the brick will melt and run down the walls of the furnace.

There is another serious thing about the high temperatures. Although the bricks may not melt, they will not have the strength to support the weight of the fire brick above the points of maximum temperature; and therefore the walls may collapse due to their own weight. That occurred quite frequently.

38 In my practical experience in connection with power plant furnaces having walls of this character, that is, of refractory material, from the standpoint of cost in the operation of such furnaces the question of maintenance was very serious. In the case of the boilers shown on the first exhibit, those boilers could not be operated continuously over about 200 per cent of rating.

The maintenance of those boilers was very expensive. We spent as much as $10,000 a year per boiler furnace merely repairing the refractory walls of those furnaces. That $10,000 was per boiler. That was merely for replacing the fire brick walls around the combustion chamber.

And there were other bad effects from the operating standpoint that you can refer to. There was the loss of capacity in the station. When one of the boiler furnaces was disabled because of damage to the brick work, it was necessary to shut the unit down; and it limited the capacity of the station.

When there are sudden large changes of load, there are expansion strains set up in the walls and these expansion strains may become so severe that the wall has not the opportunity to adjust itself to take care of the increase or decrease in the temperature; and the brick very frequently spalls off or breaks off. The high temperature is very much a factor in that.

The approximate dimensions for a unit of this size (Exhibits 1 and 2) are about thirty feet across in one direction by roughly twenty feet in the other. This is the size of the boiler unit. The horsepower of these boilers was approximately 1900 boiler horsepower. The combustion chamber in these boilers had an average height of approximately from sixteen to seventeen feet. It varied at various points across the furnace.

Q. Did the practical art know at that time, that is, in 1922, of any better construction for the walls of combustion chambers which would avoid these difficulties that you have mentioned, such as the excessive maintenance cost
when the furnace was run at higher ratings? A. I
39 should say that the best answer to that question
would be that all the power plants used refractory walls for their combustion chambers. I should think that that would answer your question in the best manner that I could think of.

This applied to the very latest plants which were constructed at the time that the Hell Gate plant was constructed. There were a number of plants around the country being constructed at that time and super-stations; and they all had fire brick or refractory furnaces.

I am absolutely of the opinion that if they had known of anything better, they would have used it. They would have used something better if it had been available at the time.

The excessive maintenance was of considerable concern to the operating engineers and the supervising engineers in the company owning this plant. If one major repair had to be made to a combustion chamber, the entire boiler unit was out of service, which would tie up the investment of about half a million dollars in one boiler unit.

The length of time out of service for these repairs varied with the extent of the damage, but it was very common to have three or four weeks loss of time.

By "outage" is meant the loss of availability of the boiler or of any other piece of equipment.

The next development in the construction of walls for combustion chambers was the development by Thomas E. Murray of the water wall construction to be used in place of the refractory walls which had been used up to that time.

By water wall I mean a wall of a furnace constructed of water tubes in circulation with the main boiler unit, the wall itself constituting the outline or the boundary of the combustion chamber, as a substitute for the refractory con-
struction which had been used up to that time. In
40 other words, the refractory wall was replaced by a
wall of tubes with metallic fillers between the tubes

to close the spaces between the tubes. An insulating material was added on the outside of the tubes to keep the heat of the combustion chamber and the heat of the tubes from being dissipated to the outside atmosphere.

Thomas E. Murray first brought this water wall construction to my attention.

Mr. Murray suggested the use of water walls for boiler furnaces early in 1923 for the Hell Gate station.

My reaction was very much against the use of water walls, as he suggested placing vertical tubes along the sides of the combustion chamber; and this brought the tubes very close to the fuel bed, which was directly contrary to what engineers had been advocating for a number of years before. They had been advocating getting the tubes away from the stoker fuel bed so that the blow pipe action of the stoker fuel bed would not puncture holes in the tubes.

Mr. Murray took the opposite position to what other engineers had taken on this question.

I also believed that there was danger that the tubes might affect the combustion of the gases before they reached the overhead tubes. The temperature of the furnace I was afraid would be lowered so much that the efficiency of the boiler unit would drop. Everyone had been advocating having incandescent walls around a combustion chamber, and that the tubes of the boiler should be shielded as much as possible from the gases in the combustion chamber.

The subject was first brought up, as nearly as I can remember it, early in 1923; and I have the drawings available which I had taken from Mr. Murray's records.

These drawings were made by Mr. A. V. A. McHarg. Mr. McHarg was personal draftsman for Thomas E. Murray.

41 I knew about the making of these drawings. Mr. McHarg's office was next to my office, and I went into his office every day to look at the drawings which he was then working on or had completed.

Mr. McHarg's practice was to put the date on the drawing as soon as he finished it. And, as the drawings were very sketchy drawings, merely studies, I think in every case he finished the drawing the day that he started it.

These drawings which I have referred to were made by Mr. McHarg in March, 1923. The first drawing, I think, is marked "March 10, 1923."

Q. Can you produce those original drawings, Mr. Lawrence? A. I can (producing drawings).

Mr. DesJardins: I have here the original drawings, photostat copies, of which appear in this book of exhibits. I would like to show these to Mr. Hostetler and ask him to stipulate that photostat copies may be received in evidence in place of the original drawings.

Mr. Hostetler: It is so stipulated.

The Court: Very well.

Mr. DesJardins: I then offer in evidence as plaintiff's exhibit 3-A to 3-G inclusive, the seven photostat copies of drawings appearing in this book of exhibits. I ask that they be so marked.

(The seven drawings referred to were received in evidence and marked "Plaintiff's Exhibit 3-A" to "Plaintiff's Exhibit 3-G", inclusive.)

Radiant heat is heat which passes through a space in the form of rays. For instance, the heat of the sun is radiant heat. The radiant heat in a boiler is the radiant heat which would be thrown from the fuel bed of the burning gases against the generating tubes of the boiler.

42 Referring to these drawings, plaintiff's exhibits 3-A to 3-G, inclusive, they show the studies which Mr. Murray made for the substitution of water tube walls for refractory walls, which had been the standard practice up to that time.

The first drawing, plaintiff's exhibit 3-A, is a study made of water walls for one of the old boilers at the Hell Gate station, that boiler being equipped with the fire brick walls. This boiler shown is the actual boiler in use at that time in the Hell Gate station.

The water walls are shown on three sides of the furnace, the fourth side, nearest the reader, being left off to show the interior of the furnace.

There are vertical tubes on each wall, the tubes being placed fairly close together, with headers at the top and bottom, and the vertical tubes.

The steam drum of the boiler is shown in the upper right-hand corner.

The conventional overhead tubes are divided into two banks, just as on the boilers in service at that time in that station. The outside of the water wall is shown encased in insulating material.

The circulation in this type of boiler is shown in exhibit 3-C, which is more or less diagrammatic for a boiler of this type. This drawing was prepared on March 13, 1923.

The water passes down through headers at the right side of this boiler unit. Some of the water turns into the horizontal steam generating tubes. The balance of the water goes down through the header at the right to the bottom of the wall, and from there flows through the headers into the vertical tubes forming the side walls of the boiler furnace. The steam is released into the steam drum at the top, and the water passes around through the cycle again.

43 It is absolutely necessary to have a positive circulation through the tubes of a water wall, as the tubes would very rapidly burn out if the water were cut off from the tubes.

The temperature of the tubes in the side walls very seldom goes over five or six hundred degrees Fahrenheit. But, if the water were cut off from those tubes, the temperature would go up to the temperature of the furnace. As a matter of fact, it would go up higher than the temperature had been up to that point, because, if the side walls no longer absorbed heat, the temperature of the furnace will go up; and the temperature of the tubes being deprived of water would go up to twenty-five or twenty-six hundred degrees very quickly. And then the tubes would blow up.

The circulation must not only be positive, but it must also be rapid, in order to supply enough water to the walls forming the side of the combustion chamber so that the temperature of the walls will be kept down, in order to take away the heat which is fed from the fire to the walls of the furnace.

The velocity of circulation in the side walls is probably of the order of two or three times the velocity in the horizontal overhead tubes, running as high as thirty feet per second. It is absolutely necessary to have that very complete supply of water to take away the heat. and in order to take away the heat, a high velocity will be caused through the tubes.

Exhibit 3-B shows another study for placing a water wall around a boiler furnace. Exhibit 3-D shows a modification where instead of the square tubes previously shown, the tubes are round and have I-bars between the tubes to close the space.

The I-bar is shown welded to the tubes in order that there may be a good thermal path for the heat from the I-bar to the tube. If the I-bar were merely set in between the tubes, it would very rapidly burn out due to the temperature of the furnace. It must be attached firmly to the tube
44 in order that the heat absorbed by the I-bar may be communicated to the tube.

Exhibit 3-E shows a further modification where, instead of the square tubes or the I-bars previously shown, there are plates between the tubes. These plates are what we call fins.

The plate is attached to the tube at one side. In this case the fin on one tube was not attached to the fin on the adjacent tubes. In other words, there was no physical connection between the two adjacent tubes. Each tube was free to expand by itself.

This shows a modification for supplying air back of the tubes.

Exhibit 3-F shows another modification where the plates at the side of the tube are bent back, and a clip is placed over the plates, forming an anchor for the insulating material on the outside of the tube.

Exhibit 3-G is a study showing another method of holding insulating material in position against the outside of the water wall, the wire mesh being attached to the water wall and forming the anchor for the insulating material.

I was present when all these drawings were made, and discussed these things with Mr. Murray practically every day in the office.

Mr. Murray discussed this subject with the various engineers of the New York Edison Company and allied companies, and received no encouragement from them for carrying on this development. In fact, I think that every one of them attempted to discourage him from going ahead.

Mr. Murray apparently was looking at the time for some concrete example by which to prove to the engineers of the Edison Company that his idea was sound; and he arranged a trip to Pittsburgh.

45 While he was there, after visiting other power plants, he took a trip through a steel mill. In the steel mill he saw a water pipe over the charging door of an open-hearth furnace. The temperature of on open-hearth furnace is higher than it is in a steam boiler.

Mr. Murray insisted on seeing where the water came out of this arch over the front door, the arch being nothing but a piece of pipe. And when he felt the temperature of the water, it was almost ice cold. He said, "Now I know I am right. We can put tubes in the side walls of a furnace, and they will stand up".

I was with him when he made the trip through that steel plant. His next step was to instruct me to lay out a water wall furnace for three boilers which had been purchased for the Hell Gate station; and he very specifically told me that all brick work should be eliminated from the boiler furnaces.

I had my engineers prepare the preliminary drawings for those boilers.

I cannot produce a copy of those preliminary drawings, as all drawings of the United Electric Light & Power Company were turned over to them when they took over the designing a few years ago.

When those preliminary drawings were made, Mr. Murray instructed me to call a meeting of the committee of engineers, who were the advising engineers on the Hell Gate station. This committee passed on all questions of mechanical design for the Hell Gate station. The committee was made up entirely of engineers.

The professional standing of those men was among the very highest in the country. They were men who had been with the company for many years, and were very prominent in the profession.

46 These drawings which Mr. Murray submitted to this committee of engineers disclosed the idea of a water wall substantially as it was used in the installation which became boilers 51, 52, and 53 at the Hell Gate Station.

Mr. Murray's purpose in submitting the drawings to the committee was to obtain their criticism. Although Mr. Murray was the consulting engineer in charge of the design of the station, and also at the same time was the vice-president of the company building the station, still he always consulted the subordinates to receive their criticism.

I was present when the drawings were submitted to the committee, as I was at all the meetings of the committee, as I was a member of the committee.

The opinion of everyone present was very much against going ahead and installing water walls on the nine boilers which had been purchased.

The most encouragement that Mr. Murray received was from one of the engineers, who suggested that the water wall be tried out on one wall of one of the three stoker-fired boilers which were being installed; but that under no conditions should the water wall be put on a pulverized-fuel boiler, such as the six which were on order at that time.

The reasons expressed for these adverse opinions were substantially as I mentioned as my basis—that the combustion might be retarded due to the temperature of the furnace being lowered; and also the possibility of danger to the tubes due to the intense heat of the furnace.

Mr. Murray at this meeting explained his idea; and he left shortly afterwards, leaving the engineers to talk it over by themselves.

The following morning he called the committee together, after they had told him that their opinion was adverse; and he told them that regardless of what they said
47 or what they recommended, he was not only going to put the water wall on the one boiler that one of the engineers had recommended, but he was going to put the water wall on every one of the nine boilers which were under contract at that time.

Mr. Murray immediately proceeded to have the boiler walls constructed; and he personally followed this work. As the subject was one of very great interest to him, and there was no precedent to guide him, he followed the work through the shop where the water wall tubes were made.

I didn't have anything to do with the manufacture of the tubes. The installation of these boilers was under my supervision.

The boiler numbers were 51, 52 and 53.

They were installed in the latter half of 1923 and the early part of 1924.

The boilers were rated at 1550 horsepower, approximately; and were designed to generate approximately 150,000 pounds of steam per hour. The floor dimensions were the same as of the boilers originally installed.

The boilers developed up to approximately 300,000 pounds of steam per hour. In fact, the capacity which was available was much in excess of what the fans could carry for any length of time. The solder started to melt on the commutator of the fan motors. In other words, the fans were not capable of blowing enough air to support the fire. We could not get any more fuel into the furnace, and we could not get any more gas away from the boiler.

The fourth exhibit in this booklet shows a cross-section of boilers 51, 52 and 53. That is the one labelled at the top "38 Hell Gate station".

Mr. DesJardins: I offer the drawing just produced by the witness as plaintiff's exhibit number 4.

(The drawing referred to was received in evidence and marked "Plaintiff's Exhibit No. 4.")

48 The following page in the booklet shows the interior of boilers 51, 52 and 53. It shows a photograph of one of the boilers.

Mr. DesJardins: I offer the photograph identified by the witness as plaintiff's exhibit 5.

(The photograph referred to was received in evidence and marked "Plaintiff's Exhibit 5".)

Referring to the drawing, plaintiff's exhibit number 4, the construction of the water walls as installed in boilers 51, 52 and 53 at Hell Gate station in 1923 was as follows. In place of the conventional fire brick or refractory wall which I have described for the boilers originally installed, we built a wall of vertical tubes with metallic closure pieces, welded to the tubes, and with refractory lining at the outside of the tubes to prevent a loss of heat to the atmosphere.

These tubes were connected to the headers at the top and bottom and to piping for connecting into the circulation of the boiler.

All of the elements constitute in effect what I call the new Murray combination.

This model will help to explain the particular construction of the water wall. The tubes are shown by these vertical pipes. The closure pieces or fins are shown by these plates attached to the tubes. They are welded to the tubes so as to form a good bond between the plate and the tube.

This (indicating) represents the bottom header of the water wall. There is a corresponding header at the top for taking the steam and the water out.

This (indicating) shows a detail of how space was provided between the tubes for access into the furnace. We merely bent the tubes out in order to get an access door.

The insulation is shown on the back. That insulation is attached to the tubes forming the water wall of the furnace.

49 This comprises all the elements which made up the wall on boilers 51, 52 and 53.

On the drawing, plaintiff's exhibit 4, the water wall corresponding to this model is shown at the far side of the combustion chamber, and is indicated by the vertical tubes.

What is indicated on this drawing, plaintiff's exhibit number 4, as the bottom header F, would correspond to this pipe, this big pipe, at the bottom of this model. And the vertical parallel lines running from that bottom header upwardly to what is indicated as upper header G would correspond to the smaller vertical tubes on the model, with fins. The upper header G would correspond to the pipes shown on the model at the upper end of the tubes. The water would come into the bottom header and flow through it into the vertical tubes upwardly and into the upper header and then out to the steam drum.

The lower part of the water wall was covered with brick in order that the fuel bed would not rest up against the cold tubes. That was done in order to satisfy some of the people who objected to the water wall. They said that it would put the fire out; take too much heat away from it.

That practice was continued, in subsequent installations, but very much reduced in area. Very little fire brick was used along the side of the stoker. In the case of powdered coal boilers every installation has absolutely no fire brick on the inside of the combustion chamber.

Now, referring to plaintiff's exhibit number 5, the water wall that corresponds to this model is shown by the vertical lines at the top of the photograph—this black rectangular space there on the photograph.

The part below that is fire brick, which I previously referred to, for covering the lower part of the wall, next to the fuel bed.

50 We found later that we had considerably too much of that fire brick in there, and reduced the area on the next installation.

The circulation on this unit, plaintiff's exhibit number 4, is from the steam drum, shown at the right, down through the pipes or tubes marked "A" into the downcomer header marked "B".

Some of the water passes through these connections described, into the horizontal steam generating tubes, indicated on the drawing, into the front header or return header at the left side of the boiler; and passes into the horizontal pipes, and back into the steam drum.

The circulation for the water wall is the same down to the bottom of the downcomer header at the right of the drawing. The water passes from the bottom of the downcomer header into the mud drum D, and thence flows across the side of the boiler to the left-hand end of the bottom header, marked F. It flows through the pipes marked E.

The water flows from the bottom header through the vertical tubes forming the water wall of the combustion chamber, into the upper header marked G.

From the right-hand end of this header the water flows through an upcomer pipe into a cross header opposite the center line of the steam drum. The water flows from this header through a number of small connections or pipes into the steam drum.

In boilers 51, 52 and 53, these water walls which I have described were applied at the sides only of the furnace, and the front and rear walls of the furnace were of ordinary refractory construction.

That represented the only use of the water wall that we felt at the time was necessary in order to protect the walls of these boilers.

51 The principal trouble with the boilers up to that time had been the maintenance on the side walls of the boiler furnaces; that is, at the sides of the stokers. And that is where the trouble came. We figured that the side walls, being water cooled, would afford sufficient protection to the front and back walls. So we didn't put in water-cooled walls for the front and back of the furnace.

Mr. DesJardins: I will offer the model that the witness has referred to, as plaintiff's exhibit number 6.

The Court: Very well.

(The model referred to was received in evidence and marked "Plaintiff's Exhibit 6.")

I was familiar with the results of the operation of the boilers, 51, 52 and 53, after they were put in service. These water walls allowed the rating of the boilers to be carried far beyond anything that we had ever experienced in our extensive experience in power house design. In fact, we never thought it was possible to get the capacity out of a boiler which we obtained out of the first boiler which was started up—boiler number 51. We absolutely got more steam per hour out of those boilers than had been thought possible. Far beyond what we thought was possible. The reason we went as far as we did was because Mr. Murray told us to just give that boiler the works; and he even didn't care if something let go. He wanted to know how much capacity could be gotten out of the boiler.

From the standpoint of saving in investment, the fact that you can get more steam per hour out of a given boiler means this. If we could, for instance, double the capacity or the output of a given boiler, it would only take one-half the number of boilers to supply the necessary steam generating capacity for the station. If we should need only half the
number of boilers, we would need only half the vol-
52 ume of building; and it cuts down the amount of pip-
ing that is necessary, and cuts down the investment of
real estate in the plant, and all the auxiliary equipment. It reduces the cost all along the line.

The engineers of this advisory committee were fully acquainted with the results that had been obtained in the operation of boilers 51, 52 and 53, and very quickly changed their attitude as to the use of water walls.

Boiler number 51 was the first boiler completed with water wall construction; and this boiler had probably received more publicity, I think, than any other boiler ever built anywhere in the world.

The results of the tests on this boiler have been published all over the world. We have accounts of papers presented in various countries. The technical magazines gave it considerable prominence. Many eminent engineers from the other side came to this country just to see these boilers. In fact, one very prominent engineer in France asked Mr. Murray to cable him as soon as the boiler was in operation so he could come over and see it.

The water wall construction at Hell Gate station on boiler-51, 52 and 53 was such an advance in the art of building boiler furnaces that steps were taken immediately to further carry out the idea of water walls; and today in large boilers there is practically one hundred per cent water wall construction around the furnace. It has entirely revolutionized the building of boiler furnaces, and has enabled the attaining of capacities far in excess of anything we had ever dreamed of.

The capacity of steam boilers has been increased from two to five times what was possible before the development of the Murray water wall.

In some plants it is not necessary to get very much overload. But in the case of central stations it is necessary to get as much capacity out of a boiler as can be economically justified.

53 Especially in the case of emergency the water wall boiler has proved of great advantage, as the capacity can be very quickly increased. Although normally this great overload is not used, in case of emergency it comes in very handy to have that capacity.

In the same floor space there are boilers operating today that have five times the capacity that was possible before the development of Mr. Murray. There are boilers today that have the capacity of a million pounds of steam per hour. And in one case for a short time, merely to find out how much capacity a boiler had, an output at the rate of a million and a half pounds of steam per hour was obtained from the boiler. Roughly, a million and a half pounds of steam would take care of the generators for the entire city of Washington, D. C.

This water wall construction makes possible this tremendous increase in boiler capacity in the following ways.

The use of this water wall construction around the combustion chamber enables the burning of greatly increased quantities of coal in the combustion chamber.

The limitation before this development was the refractory material forming the wall. The refractory materials could not stand the high temperature of the burning gases. With the water wall it is possible to greatly increase the amount of coal which can be burned in the same size furnace.

In other words, the furnace before was the limiting factor. Today the furnace is not the limiting factor. As far as I know, nobody has ever pushed a water wall furnace to the point where it could not burn more coal.

The boiler today is just the same as it was before the development of Mr. Murray's wall; that is, the boiler proper, the horizontal tubes. The boiler always had the capacity

before, but it never had the opportunity to do the
54 work because the heat could not be gotten to it; that is, the heat could not be liberated into the boiler furnace.

The tubes in the side walls form a steam generating surface, and they are the most efficient surface probably in the boiler. They generate steam at a very high rate. A square foot of surface in the water wall generates many times what a square foot generates in the overhead tubes.

That steam enters into the steam drum and mixes with the steam from the overhead tubes.

This element of the new combination, the circulating system of the water walls, not only serves to keep the walls at temperatures such that they will not deteriorate, but also serves as a valuable addition to the steam generating equipment of the boiler.

The maintenance cost of boilers 51, 52 and 53 was materially less than on the boilers which had been installed up to that time in that station.

The maintenance on boilers built since then has been reduced to the point where practically nothing is spent on the walls of the combustion chamber.

The maintenance cost was $10,000 a year for some of these old refractory wall boilers. The furnaces which we later installed in the East River station of the New York Edison Company did not have maintenance amounting to more than a hundred dollars per boiler per year, due to the complete installation of the Murray construction all around the furnace. The maintenance was practically nothing on the furnace walls. That is true notwithstanding the increased rate at which steam might be and was produced in those boilers. The output of those boilers was materially increased over the original boilers in the Hell Gate station.

55 I don't think anyone has ever been able to determine the maximum limit to which fuel can be burned in a furnace of this design. It has been our experience so far that as fast as you can feed the fuel in, it can be burned efficiently.

Mr. Murray shortly after the success of the boiler or the water wall was demonstrated at Hell Gate station, closed a contract with the International Combustion Engineering Corporation of New York to grant them a license for the exclusive use of the Murray development throughout the world. By "the Murray development" I mean the Murray water wall construction.

At the time this contract was made I was vice-president and engineering manager of Thomas E. Murray, Incorporated; and all of the preliminary work had been done in my office; and the representatives of the International Combustion Engineering Corporation came to my office to see the drawings and the studies which had been made.

I was present at the office every day; and practically every time that Mr. Murray came to the office I was there. And I was present when he was negotiating with the officials of the International Combustion Engineering Corporation.

The International Combustion Engineering Corporation was headed by Mr. George E. Learned, the president, and Mr. J. V. Santry. I met them in the office at the time.

The designs had been developed by our organization, and the installation had been made for one of our clients.

We were at that time installing boilers in the Sherman Creek station, in which the International Combustion Engineering Corporation was very much interested, as those boilers were to be fired by pulverized fuel. The combustion chambers of all the boilers which we had built and were building at that time had Murray water walls
56 on the side walls of each unit.

The negotiations were carried on over a period of several weeks, and finally consummated by the signing of an agreement of March 25, 1924, which agreement was signed by Mr. Thomas E. Murray personally for himself and his associates and by Mr. J. V. Santry for the International Combustion Engineering Corporation.

I have the agreement (producing a paper). It was signed by Thomas E. Murray, and by J. V. Santry for the International Combustion Engineering Corporation.

Mr. DesJardins: It is stipulated, I believe that we may use photostat copies of this agreement.

Mr. Hostetler: It is so stipulated.

Mr. DesJardins: I offer a photostat copy of the agreement of March 25, 1924, between Thomas E. Murray and the International Combustion Engineering Corporation as plaintiff's exhibit 7.

(The document referred to was received in evidence and marked "Plaintiff's Exhibit 7.")

The International Combustion Engineering Corporation at the time this agreement was executed was a holding company which had subsidiaries in the United States and various parts of the world. The subsidiaries were the companies which actually engaged in the manufacture and sale of equipment mainly for power plants, such as stokers, pulverized fuel equipment, boilers, low-temperature carbonization, and so forth.

The principal object of the International Combustion Engineering Corporation making the contract with Thomas E. Murray was to secure the rights to the water wall furnace or development for steam boilers which had been recently demonstrated at Hell Gate station.

The success of these boilers demonstrated that remarkable results could be obtained, and the International Combustion Engineering Corporation were very eager to secure the rights to this development. I learned that from
57 taking part in conversations between Mr. Murray
and the International Combustion Engineering Corporation representatives.

This agreement remained in force and effect until November 1, 1929. The agreement was then cancelled because of a default in the royalty payment under the terms of this agreement.

It was cancelled by the executors of the estate of Thomas E. Murray. The International Combustion Engineering Corporation was reported to be in bad financial condition, and the executors of the estate did not desire to have this contract involved in a receivership.

The International Combustion Engineering Corporation went into receivership in the latter part of 1929.

In March, 1926, two years after the original agreement, a modifying agreement was made between the International Combustion Engineering Corporation and Thomas E. Murray.

I was personally responsible, I believe, for the modifying agreement, as I recommended to Mr. Murray that owing to the development of steam boilers made possible by the Murray water wall, the International Combustion Engineering Corporation through their subsidiaries were marketing steam boilers with very much reduced heating surfaces, but with tremendous steam capacities. The result of this development was that although the capacity of the boilers went up, the royalty paid to Thomas E. Murray went down.

So I recommended to Mr. Murray that the agreement be changed, and it was changed in March, 1926. This is the original modifying agreement (producing a paper).

Mr. DesJardins: I understand that Mr. Hostetler will stipulate that we may use photostat copies of this agreement.

Mr. Hostetler: It is so stipulated.

58 Mr. DesJardins: I offer as plaintiff's exhibit number 8 the photostat copy of the modifying agreement of March 8, 1926.

(The paper referred to was received in evidence and marked "Plaintiff's Exhibit 8.")

After the agreements were executed, I received the periodical reports from the International Combustion Engineering Corporation through Mr. Murray. My duty was to check these reports to ascertain whether the International Combustion Engineering Corporation had made the correct report as to the installations for which royalty was due. A list was furnished to us every three months.

I kept track of the installations as far as I could through reading technical magazines, and also from visits to various power stations around the country. I checked these reports against the information which I had received independent of the International Combustion Engineering Corporation and also from reports of my own men who were traveling around.

What determined in my mind whether or not royalties were due on these installations was whether the installations incorporated in their construction any of the developments made by Mr. Murray on boilers 51, 52 and 53 at Hell Gate station or any improvements made thereafter.

When I say "boilers", I mean the water wall construction of the furnace. That was all.

I have the reports made quarterly by the International Combustion Engineering Corporation. These reports are headed "Murray furnaces—contracts closed"—various periods.

The sum of $379,786.43 was paid by International Combustion Engineering Corporation to Thomas E. Murray or his estate; but there is at the present time a large sum

of money involved which has not been paid by the receivers of International Combustion, but which has been the subject of many conferences between the receivers of International Combustion and the executors of Thomas
59 E. Murray. This may amount to between $150,000 and $200,000.

These payments were made between March, 1924, and November, 1929. All of the payments were due during that period, but the final settlement was not made on pre-receivership claims until a year or so ago. This amount is independent of the $150,000 or $200,000, which is still due.

The reports showed the name of the customer, the number of boilers, the horsepower of the installation, and the royalty due for those installations which were based upon the original agreement. The original agreement specified a payment per boiler horsepower on new installations and on the selling cost of old installations. In other words, where a water wall was put on an old boiler, that was paid for on a different basis from a new boiler.

I have prepared from these reports a tabulation showing such data for the installations made by International Combustion Engineering Corporation before the receivership; for similar installations, if any, made during the receivership of that company by the receivers; and also corresponding data for other furnaces designed and installed by others embodying the same Murray water wall construction. I produce that tabulation.

Mr. DesJardins: I offer as plaintiff's exhibit number 9 a tabulation which appears in this booklet, headed "Murray water wall installations," and comprising ten pages.

(The pages referred to were received in evidence and collectively marked "Plaintiff's Exhibit 9.")

The first four pages cover the installation of Murray water walls on new boiler installations, that is, where the water wall was installed at the same time that the boiler was installed: that is, before the receivership. The date, that is, the year, appears in the first column, the name of the customer in the second column, the make of the
60 boiler in the third column, the number of boilers in the fourth column, and the horsepower in the fifth column. That is the rated horsepower in each case except that it is the actual horsepower of the boilers that are included under the modifying agreement of March, 1926.

Under "make of boiler", I have "B. & W.". That means Babcock and Wilcox, the largest boiler manufacturers in the world.

On page 5 is a list of the installations on new boilers made during the receivership of the International Combustion with the exception of the last item, which was an installation by the successor of the International Combustion.

On page 6 is shown the installations on old boilers. There is merely the date of the year and the name of the customer shown there, as the International Combustion Engineering Corporation did not report the number of boilers or the horsepower of boilers, as the royalty was based on the selling cost. Those were all installations of old refractory walls which were torn out and the Murray wall put in in its place.

Page 7 shows the installations of the Murray wall construction which were designed by Thomas E. Murray, Incorporated. For instance, the first two items are the original installations made by Mr. Murray, the first one of which is the original installation at Hell Gate station—boilers 51, 52 and 53. The last two are installations for outside concerns.

On page 8 I have listed the countries in which the Murray water wall has been installed. It covers practically every country of any importance in the whole world.

The second list of names shows the prominent United States utilities and railways using the Murray walls. Practically all of the prominent utilities are listed there.

The third list on that page shows the prominent industrial companies in the United States using the Mur-
61 ray walls. It is quite a representative list.

That data was all taken from the reports of the International Combustion Engineering Corporation.

Page 9 shows the number of installations made during each year. There are the number of boilers on which the Murray walls were installed and the total boiler horsepower in that year.

The total horsepower of new boilers having this Murray water wall construction installed before receivership was 588,019 horsepower. After the receivership it was 84,143 horsepower. That is merely the rated horsepower. The actual horsepower developed was probably three or four times that.

Page 10 is a similar tabulation for the horsepower of the installations made by Thomas E. Murray, Incorporated.

The receivership was December, 1929.

In checking the royalty reports rendered by the International Combustion Engineering Corporation under the license agreement with Mr. Murray, the principal factor I considered in determining whether or not a royalty was due on these installations was whether the installations incorporated the water wall development which had been made for the Hell Gate boilers numbers 51, 52 and 53, or any improvement made thereafter.

Referring to the list of patents and applications forming exhibit A attached to the license agreement, that is plaintiff's exhibit 7, and particularly those relating to electric welding processes and apparatus, the International Combustion Engineering Corporation, at least, its subsidiaries which did the manufacturing, used electric welding; but it was not electric welding of the type covered by the patents listed and attached to the agreement. They used arc welding, whereas the patents covered resistance welding.

These patents were not a factor in considering whether a royalty was due.

62 So far as I know, every Murray water wall made by the International Combustion Engineering Corporation was done without using any of the patents covering resistance welding referred to in the agreement.

I have continued since 1923 to keep in touch with the literature relating to boiler construction.

The development on boilers 51, 52, and 53 probably received more public attention than any other boilers ever installed. The technical press throughout the entire world commented on the development, and in many cases reported the tests which had been made on the first boiler number 51.

I have clippings from technical press all over the world, and have reproduced a few of them in these photostats.

Mr. DesJardins: I offer as plaintiff's exhibit number 10 a book of photostat copies of pages of the publications referred to by the witness.

It is stipulated, is it not, Mr. Hostetler, that photostat copies of these pages of publications may be used, and that proof of the date and place of publication is waived?

Mr. Hostetler: It is so stipulated.

(The book of photostats referred to was received in evidence and marked "Plaintiff's Exhibit 10.")

Now, referring to this book, plaintiff's exhibit number 10, this first page "Water-Cooled Furnaces", by Howard W. Leitch, appeared in the technical magazine called "Power" on July 26, 1927. That is published in New York City.

The second page is an editorial by F. R. Low, the editor of "Power" on "Water-Cooled Furnaces". He comments on the experience at the Hell Gate Station. It refers to Mr. Leitch's article. That was in the same issue of "Power".

The third page is the title page or the front page of "Electrical Times", a technical magazine published in London. The fourth page is an article on page 13 of the "Electrical Times" of October 9, 1924 on the Murray water-cooled furnace wall, by David Brownlie.

63 Mr. Brownlie is an English engineer who has done considerable writing for the English technical press. This article is continued on the next two pages, pages 414 and 415, is it not.

Page 414 of that article is a tabulation entitled "Results of tests on boiler number 51 equipped with 'Murray' side wall cooling tubes". That covers the tests on the first boiler built with the Murray water walls, and it gives the results of the tests in quite considerable detail, giving the temperatures and the pressures, the quantity of coal and the quantity of water and the efficiency and so on.

I was familiar with the results. This is a correct statement of the results of those tests.

The next two pages in this book are page 29 and the title page of "The Chemical Age", issue of January 10, 1925. I refer there to an article entitled "The Murray Wall Water-Cooled Combustion Chambers".

"Chemical Age" is published in London, England.

The next page is the title page of "The Iron and Coal Trades Review" of February 27, 1925. That is published in London, England. The next page is page 346 of that issue, in which I refer to an article entitled "The 'Murray' Water-Cooled Combustion-Chamber Wall".

The next two pages are the title page and page 141 of the "Queensland Government Mining Journal" of April 15, 1925. That is published in Queensland. Queensland is one of the British possessions down in the neighborhood of

Australia, if I remember rightly. That is probably a province of Australia. I refer there to an article entitled "The 'Murray' Water-Cooled Combustion Chamber Wall. A Remarkable Invention".

64 The next two pages are the title page and page 176 of the issue of May, 1925, of the "Indian and Eastern Engineer", published in Calcutta, Bombay, and London. I refer to page 176, containing an article entitled "The 'Murray' Tube".

The next three pages comprise the title page and pages 121 and 122 of the issue of July 31, 1925, of "The Engineer", published in London, England. I refer to the article beginning on page 121 by Mr. H. D. Savage entitled "Water-Cooled Furnace Walls". The view in the upper right-hand corner is an isometric view of the Murray water wall at Hell Gate station, boilers 51, 52, and 53.

The view in the left-hand corner is an installation made at the Cahokia station of the Union Electric Light & Power Company, St. Louis. That shows the Murray water wall construction on the side walls and also on the wall at the right-hand side of that cut.

The view in the lower right-hand corner shows a suggested arrangement of a steam generating unit.

The next three pages are the title page and pages 174 and 175 of the "Engineering and Boiler House Review" of October, 1926, published in England. I believe it is published in Birmingham. I refer to an article beginning on page 174 entitled "Mechanical Stoker Practice. Recent Developments in the United States". It is the first part of that article that refers to the Murray water wall. It is at the bottom of the first column, as follows: "It is well known that the pioneer design in this respect, developed from pulverised fuel firing, is that of Thomas E. Murray."

The next three pages are the title page and pages 80 and 81 of the issue of "The Electrical Times" for January 20, 1927, published in London, England. I refer to an article entitled "Developments in Furnace Design."

65 The next two pages are the title page and page 142 of "The Engineer" for August 5, 1927. That is the same publication that is published in London, England. The part of this article on page 142 to which I refer is the description of the boiler at the Kip's Bay station, which this article states will be the largest thing of its kind in the world. That is in the last paragraph of the article.

The boiler illustrated there has the Murray water wall furnace.

The next two pages are the title page and page 167 of "The Engineer" for August 12, 1927. This is the same publication, published in London, England. I am there referring to an article "An American Diary". That describes the East River station, having these Murray water walls.

The next two pages are the title page and page 296 of the "Mechanical World" for April 20, 1928. The "Mechanical World" is published in Manchester, England. The portion of this article which I refer to particularly is on page 296 at the top of the right-hand column, where it states: "In 1923 the original installation of the now well-known Murray fin-wall furnace construction as applied to three retort-type stoker-fired boiler furnaces at the Hell Gate station of the United Electric Light and Power Company, New York City, went into commercial operation."

The next page is page 397 of "The Engineer" for October 12, 1928, also published in London, England. I refer to the column on the right-hand side of the page in the next to the last paragraph, referring to the Murray fire-wall furnace construction at Hell Gate. The next page is the title page for the article that has just been referred to.

The next five pages are the title page and pages 619, 620, 636 and 637 of the "Transactions of the American Society of Mechanical Engineers", volume 46. That was published in 1925 and covers the 1924 proceedings. That represents papers read at the 1924 meetings. 66 I refer particularly to the parts of these pages covering discussion of the boiler wall experimental work at Cahokia. I wouldn't say "experimental work". You might say "development of the furnaces at Cahokia".

And on page 620 it refers to the third step in the furnace development, and mentions that this fin type of furnace protection has been reported as very effective in the stoker-fired boilers at Hell Gate station in New York, referring to boilers 51, 52 and 53. This contains the remarks of one C. G. Spencer in discussion of the article read at this meeting. Mr. Spencer was an engineer for McClellan and Junkersfeld in New York City, who were the designers of the Cahokia station at St. Louis.

The next three pages of this booklet are the title page and pages 1123 and 1124 of volume 47 of the transactions of the American Society of Mechanical Engineers, published in 1926. I refer to the article by Broido, in which he states that attempts have been made to water-cool furnace walls, but no serious consideration was given until some of the boilers in the Hell Gate station were equipped with fin walls. Mr. Broido was a consulting engineer for a large industrial concern in New York City.

The last three pages in this book are the title page and pages 136 and 137 of volume 48 of the transactions of the American Society of Mechanical Engineers, published in 1927. These pages cover the discussion by Broido, to whom I have referred before, in which he comments on the tests of the Hell Gate boilers to which I have referred before. It begins at the bottom of page 136 and continues at the top of page 137. In fact, it goes all the way down the page.

67 The consensus of opinion of all of these articles was that the development on boilers 51, 52, and 53 at Hell Gate station was a great success and offered great possibilities for decreased cost of maintaining furnace walls, and also of obtaining considerably greater capacity out of boilers than had ever been obtained before.

The articles recognized the fact that this development was a very distinct advance in the art of boiler design: and the mere fact that it was commented on in magazines all over the world is evidence that engineers appreciated this fact.

The leading boiler manufacturer in the world in 1923 was Babcock and Wilcox. I produce a book entitled "Steam, Its Generation And Use", published in 1923 by that company. This book has been in my possession, I believe, since 1923. This book describes the history of the development of water tube boilers, and also describes and illustrates various designs of Babcock and Wilcox boilers, as well as including technical information for engineers.

Every illustration in this book showing a boiler furnace shows a refractory furnace with walls made of fire brick. The furnace wall construction shown in that book represents the highest development of the art as at the beginning of 1923.

There is in this booklet no cut or description of any wall except a refractory wall.

Mr. DesJardins: I offer as plaintiff's exhibit number 11 the book just identified by the witness.

(The book referred to was received in evidence and marked "Plaintiff's Exhibit 11.")

68 The furnace wall constructions as illustrated in this book have become obsolete today for the modern plant, except in the case of small boilers in heating a house or building, or small power boilers. But for power-station boilers that design has become absolutely obsolete.

What has rendered that design obsolete is the development of the Murray water wall; that is, the construction used in boilers numbers 51, 52 and 53 at Hell Gate station.

I am acquainted with every installation made under Mr. Murray's supervision, as well as boilers in various parts of the world incorporating this design.

The insulation on boilers 51, 52 and 53 was laid up against the tubes and held in position by a steel plate sheathing.

That insulation was supported on one side, that is, the side toward the fire, by resting against the tubes. The steel casing or sheathing was supported independently of the tubes.

At the lower part of the furnace the insulation on the outside of the wall was tied in to the refractory wall, which is shown in the photograph. I refer to that brick wall at the bottom of the water wall. That was tied in so that the entire assemblage was held together.

The insulation was placed on the outside of the water wall to prevent the radiation of heat from the walls into the boiler room. Otherwise the loss would be very high. This method of mounting the insulation on the outer side of the water wall was continued in some other installations of this Murray water wall construction. With modifications in details it was continued on all installations.

The insulation which was put on the outside of the water walls in boiler 51 comprised about three inches of refractory material directly against the tube, and then a couple of inches of magnesia on the outside against the steel
69 plate. The total thickness from the inside of the water wall to the outside was not over nine inches.

At that time there was no precedent to go by, and materials were not available, at least, readily available, for use on the outside of the walls. We didn't know exactly what to put on the outside. So we laid a fire brick against the tube, thinking that we needed that high resistant material. The weight was quite a factor. We didn't know whether it was safe to carry all the weight on the wall; that is, the weight of the heat-insulating material, the refractory material. We carried the weight independently of the wall, in order not to put the weight of that material on the tubes.

Mr. Murray, however, was very much opposed to that idea. But we engineers who had to work out all the details and live with the thing were afraid that it was trying too many experiments at one time. So we induced him to adopt that construction, although he didn't want to. Mr. Murray's idea was that the whole weight should be carried by the tubes; that the material should be fastened solidly to the tubes, as shown on the sketches in this patent application. Exhibit 3-G shows a type of construction which was advocated by Mr. Murray at the time of the building of the Hell Gate boiler. Mr Murray was very much opposed to what we did. But he went to Europe about that time, and we sort of put it over on him.

After the early installations the construction consisted of attaching the insulation directly to the wall. In other words, it was tied in to the wall at various points up along the lines of the tubes.

70 I have three photographs of an installation made at the East River station of the New York Edison Company showing this later method of assembling the insulation on the water walls. Photograph 46991 shows the Murray water wall before any insulation had been applied to the wall. That is the side away from the fire. That is the exterior of the wall. The furnace is beyond that wall.

You will note that this is a solid metallic wall made up of tubes with fins attached to the tubes. You will note that there are clips welded to the tubes, and to those clips are attached and welded rods running horizontally and vertically from the clips. Those rods are to form anchors for the insulating material to be attached to the outside of the wall.

The next photograph number 47022 illustrates the wall with the first coat of insulating material applied directly against the tubes. The insulation in this case is inside of the reenforcing rods.

The third photograph shows the second coat of insulation covering the initial coat, and also embodying the reenforcing rods within the insulation.

This is the final coat of insulation, the outside of that coat merely being covered with a hard finish to protect the insulation against damage.

These photographs were taken of boilers installed at the East River station of the New York Edison Company in 1926.

Mr. DesJardins: I offer these photographs as plaintiff's exhibits 12-A, 12-B and 12-C.

(The three photographs referred to were received in evidence and marked "Plaintiff's Exhibit 12-A", "12-B", and "12-C", respectively.)

71 Cross-examination:

The arrows in Exhibit 3-C are supposed to indicate the flow of the water and steam. We have at the bottom a lower header from which vertical tubes extend upwardly, forming a side wall. To the right we have the downcomer, showing an extensive flow of water. To the left we find that nearly all the arrows point upward—no flow downward at the left.

A hot water system in a house has its circulation brought about by the heating of water. It is not at any such high speed as is manifested in these boilers. I mentioned that some of the velocity was caused by the generation of steam in the tubes, which increased the velocity over the velocity created merely by the heating of the water.

The velocity in the downcomers of those installations that I have referred to is less than the velocity in the risers.

In the different banks of tubes, horizontal tubes, as they are called, there is not much difference in the temperature of the water in those tubes relatively. Once your boiler is heated up and the steam is being generated, it is practically all at the same temperature. The moment the water reaches the boiling point, it starts to give up steam, so it cannot exceed the boiling point very much. There is a greater pressure at the bottom of the boiler, and therefore it can reach a temperature a little bit higher; but it is very small.

The covering of the boilers with asbestos or other insulating material was not new to Murray. The mere use of insulating material was not new.

These articles in the publications to which I referred—relate to the Murray water wall development.

I believe Mr. Murray has a great number of patents on various subjects.

72 Those articles in the magazines refer to some of the features incorporated in these applications which are being argued here today.

Redirect examination:

Steam at atmospheric pressure is generated at 212 degrees Fahrenheit. The effect of greater pressure is to raise the temperature at which the steam will occur, in other words, to raise the boiling point of the water. That explains why the pressure in some parts of the furnace may cause steam to be given off at a higher temperature.

Mr. DesJardins: I wish now, may it please your Honor, in order to have all this testimony at one point, to read into the record a stipulation which has been agreed upon with counsel for the defendant, as follows:

It is hereby stipulated by and between counsel for the parties hereto that if Francis M. Fitzgerald were called and sworn as a witness in this case, he would testify in accordance with an affidavit which he has executed in this case, as follows:

STATE OF NEW YORK,
County of New York, ss:

"Francis M. Fitzgerald, being duly sworn deposes and says that he resides at Rockville Center, New York: that during the period from January 1924 to January 1926 he was Auditor for the Plaintiff, Metropolitan Engineering Company; that, on January 1, 1926 he became Secretary of that company and has continued to hold that office to this day; that, by virtue of his position with the Plaintiff, he became familiar with the license agreement of March 25, 1924 between Thomas E. Murray and International Combustion Engineering Corporation, and the modifying agreement of March 8, 1926; that, the royalties due
73 under this agreement were paid by International

Combustion Engineering Corporation to the plaintiff, Metropolitan Engineering Company, and I understand that this was done by direction of Thomas E. Murray; that the said agreement was cancelled by the Executors of the Estate of Thomas E. Murray on November 1, 1929, because of the default of International Combustion Engineering Corporation in the payment of royalties due under said agreement; that, during the life of this agreement International Combustion Engineering Corporation paid royalties to the Plaintiff, Metropolitan Engineering Company, under this agreement as follows:

1924	$25,000.00
1925	57,038.90
1926	78,997.53
1927	75,000.00
1928	75,000.00
1929	37,500.00

That, International Combustion Engineering Corporation having gone into a receivership, Metropolitan Engineering Company was awarded by a Special Master appointed in said receivership the sum of $31,250 in settlement of claims for royalties due prior to the receivership; that there is now pending under negotiation a claim by Metropolitan Engineering Company against the receivers of International Combustion Engineering Corporation for compensation for the use of the inventions covered by said agreement by said receivers in the course of said receivership which compensation the Metropolitan Engineering Company claims should amount to approximately $160,000.

Further deponent sayeth not."

FRANCIS M. FITZGERALD.

Sworn to and subscribed before me this 1st day of March, 1934.

JOHN J. MULLIN,
Notary Public.

74 *Testimony of Mr. Lawrence, Resumed.*

Mr. DesJardins: I offer in evidence as plaintiff's exhibit number 13 a stipulated copy of the pending application of Thomas E. Murray for letters patent for boilers, serial number 642,427, filed May 31, 1923, as it now stands, including the drawings, and also papers numbers 15, 18, 22½, 25 and 27 in the matter of said pending application, this being the application involved in this suit.

I may say that we have rewritten in one paper the specification incorporating the amendment, so that it is a clean copy, involving all the claims in the case in question here.

We have the drawings as they now stand. There were some views cancelled.

We have the paper by which the Examiner finally rejected claims 19, 21, and 22, and allowed claim 20.

We have the examiner's statement on appeal, another examiner's statement on appeal, supplemental examiner's statement on appeal, and the decision of the Board of Appeals.

I will ask that this be marked "Plaintiff's Exhibit 13". I may say that that shows on its face that it is stipulated.

(The document referred to was received in evidence and marked "Plaintiff's Exhibit 13.")

Direct examination (continued):

I have read and do understand the application for letters patent filed May 31, 1923, by Mr. Murray, serial number 642,427, a copy of which is plaintiff's exhibit 13.

I discussed this application and the preparation of the drawings therefor with Mr. Murray during their preparation; and, in fact, was conversant with the drawings before they were finished and before Mr. Murray decided to file any application for a patent.

The drawings were prepared in my office, or, at least, in my organization; and the drawings prepared by my organization were those submitted to Mr. Usina, patent attorney for Mr. Murray.

I followed the prosecution of this case from the time Mr. Murray presented the drawings to Mr. Usina. In fact, I was responsible for checking the original application and the various amendments submitted by Mr. Usina after that.

I don't know that drawing, Exhibit 3-A, was submitted to Mr. Usina, but the other drawings in this file Exhibits 3-B to 3-G, were submitted to Mr. Usina.

Referring to the drawings attached to this application, copies of which form part of plaintiff's exhibit 13, the boiler unit is shown in figure 1, and comprises the horizontal tubes 62—By "horizontal tubes" I mean that they are approximately horizontal, as they are in all cases of boilers of this type—connected at their front end to headers 23 at the right, and at the rear or lower end to headers 21.

The front headers 23 are connected at their upper ends to headers 48, which in turn are connected to headers 25, which is shown in figure 2, the combination of the headers 48 and the headers 25 forming the steam drum of the boiler. Instead of having a round drum, the steam drum was made up of a number of small headers connected together.

The combustion chamber is surrounded on the sides by tubes 20, which are vertical tubes extending from a lower header 32 to an upper header 30.

76 Between the tubes 20 are shown metallic closure pieces 42 in the lower left-hand corner, closing the spaces between the tubes 20. Those are indicated as broken off—the lower part of the tubes 20. They are not intended to extend the full length in that drawing. They are merely intended to be shown fragmentarily there to indicate that they were closure pieces.

In the space at the right-hand side of the drawing is shown the opening for the insertion of a grate on which the fuel would be burned.

All of the headers and tubes comprising this boiler are interconnected for the free flow of water and steam through the various parts.

Figure 2, which is a cross section of the unit shown in figure 1, shows the boiler in greater detail, with the grate 58 shown at the right-hand side of the combustion chamber, the baffle 64, directing the flow of the gases through the overhead tubes and hence out through the opening 66 at the top left-hand corner. This drawing shows how the various parts are interconnected for the passage of the fluid therein. The connection is shown at 84 in figure 1 for the supply of feed water to the boiler unit.

Figures 3, 4 and 5 show a detail of the side wall tubes 20, with the closure plates 42 and the insulating material 74 attached to the tubes and plates by reenforcing wires 76.

Those views 3, 4, and 5 correspond to plaintiff's exhibit 3-G. This forms the complete construction for the side wall of the combustion chamber.

Figure 6 shows a modification of the design on the previous figures 3, 4, and 5. This design shows a wall made of I-beams or H-beams welded together to form a solid wall. It is a solid group of tubes integrally connected, you might say.

77 Figures 7 and 8 show a similar construction.

Figures 9 and 10 show a modification, comprising a drawing of a boiler made up with walls previously shown; but the principal novelty of this drawing is the type of header which is used. The headers are horizontal for the overhead bank of tubes.

When I say "principal novelty", I mean the principal departure from the other drawing. There is no improvement shown in the water wall. It is just a different type of header for the horizontal tubes, as compared with Figure 1.

Figure 11 shows a modification of the side wall construction, in which the tubes are shown tubular; and the metallic closure plates are approximately on the center line of the tubes.

We used in the Hell Gate boiler the design shown in figure 11 on the boilers 51, 52, and 53—the round tubes with the flat plates approximately on the center line of the tube. That corresponds to that design there in that model Exhibit No. 6 except that in that model the tubes are not flanged over at the top; the plates are not flanged over at the tubes.

In figure 1 there is shown at 84 the feed water, the make-up water, connection for the boiler. That is where Mr. Murray intended to put the feed water in. His object was that he would furnish cold water to the water walls in order to keep the temperature of the walls down.

If the only water that circulated through the side walls were the make-up water which came in from this connection 84, there might be a possibility of water backing up here (indicating). But you circulate much more water through the boiler than you add in the form of make-up. In other words, there are many times the amount of make-up that circulates through the wall and also through the overhead tubes.

78 In the actual boiler this connection here comes across outside the boiler over to this end of the wall here; in order to provide for expansion of the overhead tubes independent of the side walls here. And also it made

it more convenient to get this connection here back into this stream, so that the water in that pipe is heavy as compared with the water in the vertical tubes of the wall, and that fact has a tendency to cause a flow. Of course, this is solid water, whereas it here (indicating) is what you might call light water. It might be 50 per cent filled with steam. So that the heavier column in this pipe will shove the water up the side wall.

The volume of one pound of steam, as compared with the volume of one pound of water, is about 1 to 1300. That has an effect on the circulation because the steam that is entrained in the water has practically no weight compared to the water; and therefore a column with a mixture of steam and water is very much lighter than a column of solid water, causing a pressure difference between the two sides thereby causing a flow.

This column of water in this downcomer header and the pipe leading to the bottom header of the water wall, has no steam in it. That is solid water going down to the bottom of the header.

The columns contained within the tubes of the water walls have a mixture of water and steam. It might be 50 per cent of steam or it might be 70 per cent of steam. It is very difficult to tell.

79 Referring again to plaintiff's exhibit 13, Fig. 11 of the application drawings, the plates 100 were attached to the tubes 86-A by arc welding. The purpose of the arc welding is to provide an integral connection between the plates and the tubes, so that the heat absorbed by the plates will be transmitted to the tube 86, thereby tending to preserve the plate 100, which would burn out if it were not integrally connected to the tube. That is to facilitate the feeding of heat from the plates or fins into the water tubes.

The fins 100 are overlapped but not attached together. The object of that was to give the fins on one tube the opportunity of expanding with relation to the fins on the adjacent tubes. In other words that is so as not to make too rigid a construction.

Referring now to claim 21 of the rejected claims, I am going to point out on the drawings of the application the elements which are referred to in this claim.

The claim begins: "A steam generator including in combination approximately horizontal water tubes heated by convection." The horizontal water tubes are shown on figure 1 by tubes marked 62. These are indicated on figure 9 by tubes 112.

80 The meaning of the phrase "heated by convection" used in connection with these tubes 62 and 112 is this. The tubes 62 are, with the exception of the bottom tubes just above the combustion chamber, not exposed to the radiant heat of the burning coal or gases in the furnace; but are heated by gases passing over the tubes, the gases giving up their heat by conducting heat to the tubes and thence to the water within the tubes. This form of conducting heat from one body to another is known as convection.

The heat which is given up by radiation from a hot body to another body is known as radiant heat. This is the heat which passes through the atmosphere without imparting any of its heat to an intervening body.

Heat is given up by convection when heated gas or heated air flows over a body and gives up its heat to that body. Radiant heat is similar to the heat received from the sun.

In the conventional boiler of this horizontal tubular type the horizontal water tubes are heated by convection.

Continuing, the claim states—"and a furnace having a combustion chamber below said overhead tubes." I have already pointed out the combustion chamber on the drawings of this application.

The claim continues "a wall of said combustion chamber being composed of substantially upright tubes connected into the circulation of the generator." The
81 tubes are indicated by the numeral 20 in figure 1, with plates 42 attached to the tubes.

The "circulation of the generator" is the flow caused through the tubes and other parts of the boiler by the heating of the water by the hot gases from the burning fuel. The heating causes a rapid flow of water through the various parts of the generator, accelerated as steam is formed in the tubes, causing an increase in velocity in the circulating system.

I produce a diagram illustrating the principles of circulation.

Mr. DesJardins: I offer the same as plaintiff's exhibit 14, a diagram illustrating the principle of circulation.

(The diagram referred to was received in evidence and marked "Plaintiff's Exhibit 14.")

Now, referring to this diagram, plaintiff's exhibit 14, figure 1, the flame at the left corresponds to that which is applied to the tubes of a boiler. The effect of that is to produce hot water and a mixture of hot water and steam in the left-hand leg. That makes the water column in the left-hand leg of the loop lighter than that in the right leg. That sets up a circulation in the parts of the loop.

Now, referring to figure 2, in that there is a flame applied to both legs. The effect of that is to heat both columns of water equally and to produce in each a mixture of steam and water and a tendency to flow upward in the direction of the arrow. With this loop here, if the same amount of heat is applied on each side in the same manner, there is no tendency for an upward flow on either side. In other words, it is like boiling water in a kettle. It will bubble all over. There will be no definite circulation in there.

82 Mr. DesJardins: I offer in evidence as plaintiff's exhibit number 15 a diagram illustrating the circulation of the conventional horizontal water tube boiler, which corresponds to that enlargement on the board.

(The drawing referred to was received in evidenec and marked "Plaintiff's exhibit 15.")

Referring to plaintiff's exhibit 15, the horizontal water tubes here correspond to the left-hand leg of the loop shown in figure 1 of plaintiff's exhibit 14. That is where you put the heat on the system. The circulation in this boiler is from the steam drum here down through this circulating pipe here into the lower header, and then through the horizontal tubes to the upper header at the left-hand side. The mixture of hot water and steam goes up to the top header, and then through the series of pipes back into the drum, where the steam is liberated and goes out through the connection at the top; and the water returns to the circulation again.

If those tubes were perfectly horizontal instead of as they are you would get a very irregular flow. You would get a pulsation with no definite direction to the flow at all. It might shoot out this way one instant and out the other way the next instant. It would not go up toward the top. You wouldn't know what would happen with a thing like that.

The tubes are always given a slight incline so as to direct the flow.

Mr. DesJardins: I offer as plaintiff's exhibit number 16 a diagram illustrating the Murray water wall for combustion chamber with vertical tubes connected in the circulation of the boiler.

(The diagram referred to was received in evidence and marked "Plaintiff's Exhibit 16.")

83 Referring again to claim 21, the upright tubes of the wall are further defined in that claim as follows:

"said tubes being spaced apart a distance not substantially greater than their diameter, and metal extensions from said tubes united thereto with good heat conducting joints and practically closing the spaces between them and providing an increased area exposed to the direct radiant heat of the burning fuel and conducting such heat to the tubes, each of said extensions being limited in width as a maximum to the diameter of the tubes, the tubes and extensions constituting a substantially closed wall exposed on the inner face only to the combusion gases."

By this claim we mean a steam generator or a steam boiler which includes in combination the horizontal tubes shown on that sketch on the board there (referring to plaintiff's exhibit 16) and a wall of vertical tubes, as shown on the diagram, the two being connected so that the flow from one set of tubes mingles with the flow of the other set of tubes at some point in the cycle through the boiler parts. The tubes are spaced apart a distance not substantially greater than their diameter. The object of that is to have the tubes close enough together so that the closure pieces between the tubes will not be of an excessive length, that is, excessive length or width or whichever you want to call it, from the tube to the outermost part of the closure piece. The reason that it is not practical to have an excessive length of the closure plate out from the tubes is that the heat will not be transmitted back to the tube if that length is too great. In other words, the metal has a certain capacity for transmitting heat; and we found that that distance out from the tubes was less than the diameter of the tubes. In other words, that is the very maximum which we considered at the time could be used. 84

The object of the good heat conducting joint is so that the heat absorbed by the closure plate can be transmitted to the tube. If there is not a good heat conducting joint, the heat will not be transmitted to the tube, and the closure plate will very quickly oxidize and burn away.

I refer to as the closure plates are shown on this model. These are the closure plates (indicating). We call those in practice the fins.

As a matter of fact, this model is not strictly in accordance with the claim in the spacing of the tubes. This model was made up when we were first studying this problem of a boiler wall; and this here was Mr. Murray's first idea as to how to make it. But when we got into a real study of the subject, we found that it was impossible to space the tubes very far apart, because the plates would burn off.

There is another very good reason for keeping the distance down. If these plates are too wide, there is a terrific stress set up in the plates, which causes the plates to crack.

If a crack starts out here (indicating the outer edge) and the plate is wide these plates being separate between the tubes, that crack will work right down through the plate, and eventually extend right through the boiler tube and allow the high-pressure steam and water to shoot out through the crack.

We have had that trouble where we tried to go too far with the plates, where it was impossible to use a short
plate. We filled it up with metal, never thinking we
85 would get cracks. We figured that they might burn
off, but this is something that we had not figured on.

The closure plates, because they are integrally connected to the tubes, provide an increased area exposed to the heat of the furnace, which absorbs the heat of the furnace and transmits it back to the tube. If the tube is heated, the water is heated within it.

We found that that was the maximum distance which could be used between the tubes.

That is shown in figure 11—the design which was actually used.

These plates and these tubes are exposed to the heat only on the furnace side of the wall, the outside being covered by an insulating material such as we have shown there.

There is an advantage in this construction comprising vertical tubes with the metallic fins and extensions from the standpoint of making it easy to make openings in the wall where necessary. If the tubes were placed solid together, there would be no chance to provide what we call peep holes so that the fireman can look through the wall of the boiler. For instance, if a man wants to see into the furnace, we can just cut this plate out and provide an opening large enough so that a man can look in.

If it is necessary to have access to the furnace, we can spread these tubes, as shown on this model, large enough so that there can be access for a man right through between the tubes.

86 If the tubes were solid, it would not be possible to spread the tubes like that. They would have to be bent out into the aisle, which would take up aisle room and would not be a good form of construction.

In claim 24 the tubes of the combustion chamber wall are stated to have "metal extensions from said tubes attached thereto with good heat conducting joints and practically closing the space between them but being free to move separately". The reason for that phrase is that not all tubes in a boiler furnace are subjected to the same temperature. For instance, the fire may be more intense at the center of the furnace than it is toward the end. The result is that more steam is generated in the tubes at the center, and the temperature of the tube wall becomes higher than it does at the end.

If the temperature is higher on the center tubes, the center tubes will expand more than the tubes, say, at the end of the furnace. As they are fixed to a common header top and bottom, if this were welded together solid, it would make a very rigid structure. The center wants to expand more than the end tubes. It would set up excessive strains in the wall structure if all the tubes were welded together solid. That is the reason for allowing the tubes to be free—so that they can expand independent of the other tubes. It makes a very much more flexible wall and prevents excessive strains.

The Court: That is not covered by this claim 21?

Mr. DesJardins: No, your Honor.

The Witness: That was not in claim 21.

87 Mr. DesJardins: I may say that that limitation occurred in the allowed claim 20, and it also occurred in this claim 24, which the Board of Appeals refused and re-

jected, notwithstanding the fact that the Examiner in his supplemental statement had indicated that it was allowable. It was probably an oversight. I think the Board of Appeals perhaps entirely overlooked the Examiner's statement there.

Mr. Hostetler: We have gone into the matter, and Mr. Des Jardins is correct. It was an oversight in not allowing that claim. We waive the rejection to that claim.

Mr. DesJardins: You are willing to consent to a decree as to claim 24?

Mr. Hostetler: As to claim 24.

Witness continues: The boilers numbers 51, 52 and 53 at Hell Gate station comprise all of the elements covered in the patent application 642,427. They are connected in the same arrangement as shown in the application.

There have been constructions in which the tubes are rigidly attached to each other. The claim is made that those pieces between the tubes remain rigidly connected. As a matter of fact, after a year or so those closure pieces are no longer rigidly connected; but the tubes are sliding through the pieces. So that the strains which have been set up have loosened the joint. But as erected in the first place it does get around our claims where the tubes are separate from each other. In that construction, they are rigidly connected at the start, but gradually work loose, so that after a while they are not rigidly connected.

88 Mr. DesJardins: May it please the Court, in order that we may have before us the patents on which the Board of Appeals rejected these claims, I offer in evidence as plaintiff's exhibit 17 a book containing the patents set up in the answer. There are four patents. The names appear on the outside of the exhibit.

(The document referred to was received in evidence and marked "Plaintiff's Exhibit 17.")

Referring to the Griffiths patent No. 743,271, appearing in this book, the boiler consists of the steam drum 21 in figure 5, with horizontal convection tubes 22, headers at each end of the approximately horizontal tubes—with the headers 23 and 24 at the ends of the tubes 22; the side wall tubes 33, the grate 18, a lower header 32 for the side wall tubes, baffles 41 in two locations among the horizontal tubes—those are the solid lines—one in the heart of the approximately horizontal tubes—and the other at the top—a bridge wall formed of tubes 20, that vertical set of tubes there right near the center, in the lower part of the drawing. The fire door 30 at the lower left; an insulating casing 16—that is across the hearth—a steel casing outside of the insulating material, which is marked 11, 12, 13, 14 and 15. They don't all appear on this drawing. 13 and 14 are on figure 5.

A feed pipe. That apparently is the pipe shown coming in at the upper left-hand corner of the boiler, although that might be the steam outlet. He does not indicate what it is.

89 The fuel is burned on the grate 18; and the products of combustion pass among the tubes 22 in the lower bank and out through the opening between the upper and lower banks of those horizontal tubes, around the right-hand end of those horizontal baffle tubes.

The gases pass through the upper approximately horizontal tubes, over the end of the upper baffle, and then back parallel to the steam drum, and out through the opening 27, which is the connection to the stack.

The water in the steam drum is supposed to have its level between the upper and lower tubes entering the steam drum. That is, the tubes 33 enter into the steam drum at two different levels, as shown in figure 3. That dotted line across the boiler indicates the level of the water. The dotted line indicates the water level, which is supposed to remain stationary between the upper tube 33 and the adjacent tube 33.

As a practical matter, however, the level in a boiler never remains constant. We know that from looking at the water glass in a boiler in our own home. Even there with very little evaporation, the water level fluctuates. In a power boiler this fluctuation is very much accentuated and may vary from 12 to 18 inches depending upon the output of the boiler.

In other words, this boiler has a theoretical water line, which in actual practice could not possibly exist.

90 If the boiler when started up has the water line, as shown by the dotted line—and as Griffiths states in his patent, it should be between the upper and the lower openings—when the heat is applied, the water in the tubes

and in the side wall will expand; and that water line must rise above the upper openings, or, at least, up to the upper openings, in order to take care of the expansion of the water.

If the output of the boiler, the steam demand of the boiler, should be increased suddenly, the volume in the side walls and in the horizontal tubes must be occupied partly by steam, which will displace water; and that displaced water has only one place to go, and that is up into the steam drum. So the result is that the water line will rise, and it might even go up a foot or more.

Now, on the other hand, if the demand on the boiler should suddenly decrease, as would happen if the fire should go out due to mechanical troubles, or if the load required of the boiler should be suddenly decreased, the tubes on the side walls, which are partially filled with steam, must immediately release that steam, as there is no more heat being applied. The space occupied by the steam will be filled by water. The water can only come from one place and that is the steam drum. The result is that the water level in the steam drum will drop. It may drop a foot or more. The result is that there will be no water going down into the side wall tubes, as the water level is below the side wall tubes when that happens.

91 Assuming that the steam drum 21 of the Griffiths patent is filled with water until the water level assumes the position indicated by the dotted line in figure 5, and assume that there is no fire on the grate 18, all of the side wall tubes would be filled with water. The approximately horizontal tubes would be filled with water. The various headers and the various baffles all would be filled with water.

Assuming that a fire is started on the grate 18 and the fuel burns at the intended rate, so as to send a stream of hot gases through the path indicated, the first effect would be to heat up the water in the entire system. This would tend to cause a flow upward in the approximately horizontal tubes and in the side wall tubes. There would only be a slight tendency for that flow before steam is generated. There would probably be some flow down the side wall tubes.

But as steam is formed, then the conditions will become entirely different. When you generate steam, I believe that the flow will have a tendency to go upwards in every tube of that boiler. In other words, there will be no downward flow which could supply the horizontal tubes and various other parts of the boiler.

This I can illustrate probably better from the diagram. (Referring to diagram illustrating the Griffiths construction.) Here is the fire (indicating). In order to make this Griffiths boiler work, water must come through one of the lower pipes down through some of these side wall tubes. Naturally, if the level is below the opening, no water can come down. If the level is above the upper tube, we have not the condition which exists, as stated in the Griffiths patent.

92 Now, if we apply heat on two tubes, these two tubes (indicating), the same heat heats this tube (indicating) and this tube, and that heats this tube. In other words, we have heat imparted to the water in each one of those tubes; and the tendency is to try to cause a flow upward. I refer to the two tubes marked "downcomer tubes". Now, what will happen will be that you will blow a column of water out of each one of those side wall tubes, and you would probably get down to the point where you will be just making steam here (indicating) without having any flow through the tube at all. In other words, you would keep on generating steam here until all the water was turned into steam. The only water is that which is in the tube at the start. With this design of boiler no water in my opinion can come back from the steam drum. In other words, it is a boiler that could not possibly be operated, for the reason that we have not the means whereby you are assured of a flow from the drum down into the vertical tubes on the side wall.

Another thing. It is impossible to get flow without a drop in pressure. You must have a pressure loss in order to get flow. A difference in pressure. Now, in order for water to get into one of these tubes from the steam drum, there must be a difference in pressure.

If the top of this tube is right at the water line, as shown in the Griffiths patent, the effect would be that the moment water tried to flow into that opening, there would be a reduction in pressure.

Now, as the water is already at the boiling point in the drum, the moment the water tried to get into that tube, there would be steam formed, because, if you take water at the boiling point, although you may not be generating steam at the moment, if you reduce the pressure, you will immediately generate steam.

93 The result of that would be that the top of these tubes would become steam bound; and as the steam could not flow downhill, it would have to remain in the tube, and it would block the flow of water from the steam drum into that tube.

Referring to the tubes marked 41—that is, the baffle tubes—and the tubes marked 20—that is, the bridge wall tubes—and to tubes such as 42 and 43, the object of these is to form baffles. Now, those tubes are connected at each side to the side wall tubes. In other words, here is a wall on one side, and there is another wall over here (indicating). These tubes are connected from the tube on one side to the tube on the other side. In order to get a flow, as I mentioned before, there must be a difference in pressure. If there is no difference in pressure, there is no flow. These tubes, being connected at the same level on each side of the boiler furnace, are connected to points of the same pressure; and therefore there can be no definite flow through these tubes. The result would be that those tubes would burn out in a very short time.

Those are horizontal tubes, such as I mentioned earlier, where there would be no tendency to flow in either direction. I mentioned that there could not be any definite flow in a horizontal tube like that, connecting to points of the same pressure.

The baffles 41 are shown on the patent drawings in that position there (indicating).

Now, referring to the inclined tubes 22, which I called approximately horizontal tubes, there is only one way of getting water into the approximately horizontal tubes, and that is from the bottom header called the mud drum. The water must come down from the side wall tubes into the bottom headers. And here (indicating) we have a connection from the side walls to a cross header.

94 The water flows from the mud drum, figure 2 of the patent drawings, into this cross header, and up this way (indicating) into the approximately horizontal tubes, flowing this way, and up to the steam drum.

That is the way it is supposed to happen. But, if the water cannot get down through the side wall tubes, it cannot get into this cross header. And, if it cannot get into the cross header, it cannot come up here into the drum.

The water and steam are coming through the horizontal tubes in this direction (indicating), that is uphill. And this must be relieved through the upper connection into the steam drum. So that it would be impossible for the water to come back through that connection rather than through here (indicating).

The purpose of inclining those approximately horizontal tubes is to make sure that the flow is in a definite direction.

Mr. DesJardins: I offer as plaintiff's exhibit number 18 a copy of the chart entitled "Diagram Illustrating Absence of Circulation from Horizontal and Vertical Tubes of the Griffiths Boiler."

(The diagram referred to was received in evidence and marked "Plaintiff's Exhibit 18.")

In my opinion the steam boiler shown in the Griffiths patent absolutely does not have a circulation; for the reasons I have indicated.

If I had to start a powdered coal fire in that boiler, I would run to the door as fast as I could. It is absolutely unsafe. I don't know that that boiler has ever been built.

95 We have made inquiries to try to find out whether or not a boiler, as shown in the Griffiths patent, has ever been constructed. So far as we could find out, the boiler has never been built.

My opinion that the boiler of the Griffiths patent is inoperable is based upon its lack of circulation and that opinion is confirmed by other engineers of considerable standing, with whom I have discussed the construction of the Griffiths boiler. I don't know that I can state the names of all the people I have discussed this with. But, I discussed it with Professor Christie of Johns Hopkins; and he gave me his opinion that that boiler was not an operative boiler, which coincided absolutely with my view.

In my opinion, the vertical tubes marked 33 in the Griffiths patent are not connected into the circulation of the generator. The water would not get from the steam drum to the approximately horizontal tubes; and, if this is the case, there can be no circulation of the steam generator.

The vertical tubes 33 of Griffiths are not spaced apart. They are placed one against the other. There are no extensions from these tubes.

The combustion chamber wall of the Griffiths patent, I would say, is the insulating material 16 and the plate on the outside of that insulating material 13 and 14 and so forth. This can be seen by reference to figure 3. The gases can circulate through that boiler.

At the top of the figure, you will notice that the tubes 33 are spaced apart. Now, the gases can go through that opening into the space between the tubes and the insulating material, so that there would be a tendency for circulation of hot gas through the space on the outside of those vertical tubes. The effect of that temperature would be to deteriorate the asbestos. I think he uses the word "asbestos" here in one place. Yes. He says "asbestos". The asbestos would not last very long.

96 I note in the Griffiths patent the following statement of the object of the invention, appearing on page 1, lines 10 to 19, as follows:

"the same has for its object more particularly to provide an internally-fired sectional water-tube boiler presenting increased heating surface and capable of holding a large body of self-contained water separated into numerous small volumes, whereby to insure rapid evaporation and production of dry steam, induce a more perfect circulation of water, and yield a steady water-line."

This construction illustrated by Griffiths would not accomplish the objects which Griffiths states in his patent.

There is nothing in this patent which would enable anybody to burn a greatly increased quantity of coal and secure a good circulation in the boiler.

This patent teaches the art absolutely nothing. I would say that it leads the art in the wrong direction.

I don't think that this boiler would be passed by any boiler commission in the entire United States. It is absolutely unsafe.

The boiler illustrated in the McClellon patent number 1,474,156, issued November 13, 1923, is a boiler of the locomotive type. It is a fire-tube boiler; not a water tube boiler, as called for in our application.

A fire-tube boiler is practically a tank through which there are a number of tubes passing. The gases flow through the tubes which are in the tank. The gases heat the tubes, and this heat passes through the outer wall of the tubes into the water. It is just the reverse of what occurs in a water tube boiler, where the water is on the inside of the tube, and the gases are on the outside of it.

97 The problem- which I mentioned in connection with the water tube boiler for power plant use are not encountered in the construction and operation of a fire-tube boiler.

The fire-tube boiler is in a different class than the water tube boiler, and is used mainly in locomotives or for small industrial power plants where cheapness in the case of the industrial plant is the principal consideration.

The water tube boiler has not been developed for locomotive use except in a few experimental cases, whereas the fire-tube boiler has been the standard type of boiler, I believe, since the first locomotive was used.

The boiler illustrated in the McClellon patent consists of the steam drum 1, which is the principal part of the boiler—this large drum. That is what I referred to as a tank.

In figure 1 at the front end of the drum 1 is shown an extension which is illustrated further in figure 2. There are three extensions, numbered 11 and 11. They are shown in figure 5 in cross section.

These are what McClellon calls crown drums. They are merely extensions of the main drum 1. The tubes 79 in figure 5 are shown at the side of the fire box. Those are water tubes at the side of the furnace. The fire tubes are indicated by the numerals 3 and 5. 5 appears right under the center crown drum. 3 appears at each side near the bottom of the main drum.

The mud ring 58 is shown at the bottom of the side tubes 79.

The arch tubes 115, and the firing door is shown by numeral 63 in figure 1.

98 These form the principal parts of the boiler, with the exception of short tubes or headers in various parts.

The grate is located along the line A—A in figure 1. It is right near the bottom of the drawing. It is a dotted line with letters just at the ends.

The gases of combustion pass from the fuel bed A—A vertically and then around the right side, right-hand end, of the horizontal baffle 120. That horizontal baffle rests on those tubes 115.

The gases then flow parallel to the crown drums, approximately parallel, and enter the fire tubes 3 and 5. At the ends of those tubes the gases pass to the smoke stack of the locomotive.

The crown drums 9 and 11 may be considered merely as extensions of the tank 1.

The McClellon patent does not show a steam generator which includes approximately horizontal water tubes heated by convection. It does not show a combustion chamber below the horizontal water tubes. I would say there is no circulation in the boiler shown on the McClellon patent.

The gases circulate through the tubes, but there is no circulation as we speak of circulation in the main part of the boiler, as there is nothing to form a definite direction of flow in a boiler of this type. It is very haphazard. The steam comes up almost in any place.

There is not in the McClellon patent a combustion chamber wall composed of substantially upright water tubes connected into the circulation of the generator.

99 Referring now to the fire-box wall of the McClellon patent, I do not find in that patent any sheathing of insulating material united to and supported by such wall.

In figure 2 of this patent 87 and 89 show insulating material and a cover plate on the outside of the insulating material. It is not united to and supported by the wall of the combustion chamber.

There is nothing in the McClellon patent which would lead anyone to make use of the same for developing a furnace for stationary boiler use. The McClellon construction is only a modification of the furnace wall which has been used on locomotives for years and years. In other words, McClellon merely replaced the hollow side wall type of boiler furnace by a type of tubular construction—merely a change in the form.

I believe it was suggested by the Board of Appeals, that McClellon would teach one to space the vertical tubes 33 of Griffiths and to put metallic extensions between such spaced tubes. If one should do that, it could not cure the objections which I have noted to the construction of the Griffiths patent. I would say that it would make the Griffiths boiler worse, as each tube would have to absorb more heat and therefore would require more water. As there is already a deficiency of water, the condition would be aggravated.

The Junkers patent number 1,125,113, does not show a boiler furnace, or, for that matter, any kind of a furnace, in this particular patent. It is necessary to refer to a prior patent of Junkers in order to find out the use to which this wall is intended. You have to refer to patent number 1,085,341, which is mentioned in the Junkers specification.

Now, if you refer to that prior patent, you will see
100 that it does not refer to a steam boiler. It refers to
a hot water heater, as they are used in your home for heating hot water. It is not a steam boiler, and certainly not a steam boiler for power use. It is merely a hot water heater.

The Junkers patent number 1,125,113, shows a proposed form of wall for a combustion chamber. Junkers proposes using water tubes on a wide spacing with flat or curved plates to enclose the space between the tubes. Those tubes are indicated at 2. The flat plates are indicated by 1 in the first figure.

The plates are in some cases, you might say, lapped around the tubes. They are not attached to the tubes in the manner which I have shown on the model, which was used by Murray, Plaintiff's Exhibit number 6. These tubes are spaced much too far apart for use in a boiler of the type we have been discussing. The plates would be much too wide to stand the excessive temperature of a boiler furnace, and excessive strains would also be set up by the temperature of these plates.

The type of hot water heater that Junkers proposes this wall for is a heater with a water coil through which a gas flame passes. The tubes 2 are the separate rings of the spiral coil. What he proposed was simply to put strips between the individual rings of the spiral coil. The temperature in a hot water heater would be very low. It wouldn't even be half the temperature of a steam boiler.

In figure 4 they attach the tubes to the plates at the side. But the defect in figure 4 is that the plate 5 on one tube is attached to the plate 5 on the adjacent tube. In other words, it would make it a very, very rigid structure; which would set up excessive strains in the structure. It could not be used for a power boiler at all.

101 The plates 5, even though they were not attached to each other, are so wide that they possibly could not last long. My prediction would be that those plates would crack through to the tubes inside of two weeks, from our experience with fins of the type that we have been using. That is because the plates are very much wider than the maximum diameter of the tubes. But the worst defect, I think, or one of the worst, is that the plates are attached together, which is a very bad thing in a boiler. That is serious when you have plates much wider than the diameter of the tubes. The further apart you have the tubes 2, the worse strains will be set up in the plates 5. Take figure number 1, for example, where the plate is wrapped around the tube. That plate could not possibly remain attached to the tube 2 as shown, because the expansion of the plate 1 would just tear that plate off the tube. It is an ideal arrangement for pulling the plate away from that tube.

The Breen patent, number 590,962, shows a hot water heater. It is not a steam boiler. It is the ordinary construction used in household service for hot water heating. There is no circulation within this hot water heater. The circulation must be through the whole house heating system, up through the radiators and various risers and the expansion tank. There is no circulation within this. It is merely a hot water heater such as has been used for many years.

I can see no resemblance between this patent and the Murray construction at all.

There is absolutely nothing, in my opinion, in these four patents in this book, plaintiff's exhibit 17, which would lead anyone to develop the wall as described in the Murray application.

102 In my opinion no engineer, exercising merely the usual skill of an engineer in this art would, from a study of the four patents included in exhibit number 17, arrive at a boiler construction such as that of the Murray application or of boiler 51 at the Hell Gate station.

Cross-examination (continued):

In the Griffiths patent as shown on the drawing an engineer could not control the water level. In a boiler built from this patent my opinion is that the water level could not be maintained as shown on the patent. The water fluctuates in any steam boiler with fluctuation in the demand.

In an ordinary boiler when the water level gets below the crown sheet, you may burn out your crown sheet if the water is off of that crown sheet too long. Momentarily it would not burn out. The crown sheet is the sheet of metal over the fire box.

When the water level gets below that, there is likely to be an explosion if it was a stationary boiler, but in a locomotive boiler, with the agitation that it gets, the wall of the furnace would probably be kept wet on the inside surface. It does not necessarily mean that you would get an explosion immediately.

It is possible for a man to operate this device (referring to plaintiff's exhibit 18) so as to keep sufficient water in there (pointing to the steam drum on the diagram) to cover the openings of these tubes, but he does not say that it can be operated that way. He says that the water line is between those openings, and that was apparently a very essential point in his ideas on the circulation of the boiler.

103 The water line in the boiler of the type shown by Murray is approximately at the center of the steam drum.

An engineer cannot maintain it right at that point. It is not necessary to maintain it there.

The water level in Griffiths, I should say, would have to be above the top tube of that boiler; and even then the flow would not go down through the tubes. It certainly could not do that as shown by Griffiths.

I don't believe the water would descend down the rear end of this boiler when the heat is at the front end to a sufficient extent to supply the side walls. There might be a slight flow at the very ends of the boiler. But the flow would be so slight that it would not even take care of the side walls.

There are many points of difference between Griffiths and Murray. In the first place, on the Murray boiler the water is not taken off at the center line. The water on the Murray boiler is taken off at the bottom of the drum. Even assuming that there is sufficient water in the steam drum to supply the boiler, they are not comparable.

In the first place, the Murray tubes are not fed the same as this. The Murray tubes are fed this way: The water for the Murray tubes comes down through this header (referring to plaintiff's exhibit 16), which is not exposed to the heat of the furnace. It is at the rear end of the boiler and is not in a hot spot. This is a relatively cool location for the header.

The tubes in the horizontal bank are exerting a flow toward the left-hand header, which exerts a flow down on this return header. That is not true of Griffiths because every one of the tubes, practically, except the end ones is exposed to very high temperature. There are only about three or four tubes that are in any way protected from the extremely high temperature of the furnace—just the ones at the end.

104 Now, every tube in the side wall of Griffiths is exposed to the extremely high heat of the furnace, tending to cause a flow upward.

In the Murray construction the side wall is fed from the bottom of this header (indicating the downcomer header on the diagram), which we know from many years of experience always contains water at the bottom of that header. Boilers have been built this way for forty or fifty years.

This downcomer header here (indicating), as was actually installed on boiler 51, was taken around the boiler to the far side, in order to take care of the expansion of the various parts. This connection was taken back here.

But let us assume that it comes down as shown on the patent drawing. This here is a relatively short length compared to the length of the tubes in the side walls. In other words, if we have a longer leg here exposed to the heat of the furnace than we have back here, we are going to have a difference of pressure, tending to cause the flow to come from this tube here or this header into the side wall tubes, and therefore up to the steam drum.

In other words, if you have two surfaces exposed to the same temperature, the surface which is of the greater area will absorb the more heat; and therefore there will be a greater tendency for flow. This cross header is shown very close to the fire. There is no wall here (indicating).

Q. This inlet header is shown much farther away from the fire and is protected by a bridge wall. Why isn't the water in this inlet header cooler than this is there (indicating)? A. All of the tubes are exposed to the heat of the furnace; some to a greater extent than others. But we have a tube here and a tube here, and the water-level is

indicated above there. The heat absorbed by the tubes—this tube here—is the same as the heat absorbed by this
tube here within such a small degree as would not
105 be consequential. In other words, this tube here
will take all the water that will come down from that tube there. The differential in here can be so slight that the water that will come through one of the down headers will go back through the adjacent tube.

It is absolutely not a fact that Griffiths in his patent, which was issued more than thirty years ago was a pioneer in teaching the steam engineers of the profession the building of boiler walls formed of tubes. If Griffiths had made a real contribution to the steam boiler art, his development would have been used. So far as I know, no boiler has ever been built according to the Griffiths patent.

It is a fact that engineers in building boilers do not necessarily copy the direct proportions of a boiler in a boiler patent. I know nothing about the airplane industry.

In the Griffiths specification, first page, line 44 reads: "In said drawings"—referring to the Griffiths specification—"10 designates the boiler, comprising an outer casing 11, consisting of sides 12 12, back 13, front 14, and top 15, all composed of metal sections suitably secured together upon their outer surfaces and provided upon their inner surfaces with a lining 16 of asbestos or other fireproof material."

I don't believe that asbestos used on the Griffiths boiler would last. I admit that some other fireproof material would last, but it could not be built with asbestos. Because asbestos would not stand the temperature of the gases which would come in contact with the insulating material.

Mr. Hostetler: Now, in regard to the McClellon patent, number 1,474,156, in answer to your Honor's question whether the Patent Office relied upon that, I will state that we rely upon only the construction that is referred to on page 3, line 50, as follows:

"The spaces between the side walls of the tubes may be closed by fillers 89 welded thereto, thereby forming a side wall which, in effect, is an integral whole."

106 The patent discloses that structure as stated in the specification.

And farther on in the same column, line 58; "The outer faces of the side walls may be covered by asbestos or other appropriate material."

Now, in regard to the Junkers patent, No. 1,125,113, referring to Fig. 3, it refers to those connecting portions as S-shaped. If connecting portions between the tubes were constructed S-shaped, as they are shown, that would not permit expansion and contraction. Not altogether. No. It would not, because you would get a differential expension between adjacent tubes which would not be taken care of by that construction.

In regard to the Breen patent, No. 590,962, the part relied upon there is on page 2, line 58, as follows: "When these heaters are set up, they are to be covered with some non-conducting material or substance in order to prevent radiation, and for this purpose I employ a plaster in which asbestos forms a large part of the material. For securing this covering on the heater I provide a wire-netting w, which is passed over the heater and is fitted over the lugs or projections" and so forth. That is common practice—to cover boilers of various kinds.

In the Griffiths patent (referring to the diagram, plaintiff's exhibit 18), a baffle is shown intermediate the two sets of horizontal tubes at the fo-ward end, and above the bank of tubes at the rear. The heat transmitted to these lower tubes would be by radiation and conduction both.

The upper tubes beyond the baffles particularly would be shielded from the radiant heat, and would be heated by convection.

In all of these boilers heat is transmitted from the furnace fire by conduction, by radiation, and by convection. By conduction from the steel parts of the boiler to the water. And by radiation where the rays could reach and were not intercepted by other tubes or baffles. By convection in any place that could be reached by the
107 gases of the burning fuel.

Redirect examination:

I did not intend to say that the Griffiths boiler could be operated if the water level were above the inlet ends of all the tubes 33. I don't concede that it could even be operated then, because the water, even if it did flow down through certain of the pipes forming the side wall, would not get into the cross header, shown here (indicating). It would not come in. here and then come up here from this mud header to supply these tubes here. I don't concede that it could be operated.

The water cannot flow downwardly through the inlet header on the chart, plaintiff's exhibit 18, because it has no connection at the top of the steam drum.

The water cannot flow downwardly through the tubes marked 24 on the Griffiths patent, because there is no connection at the top of this header from which the tubes can receive their water supply.

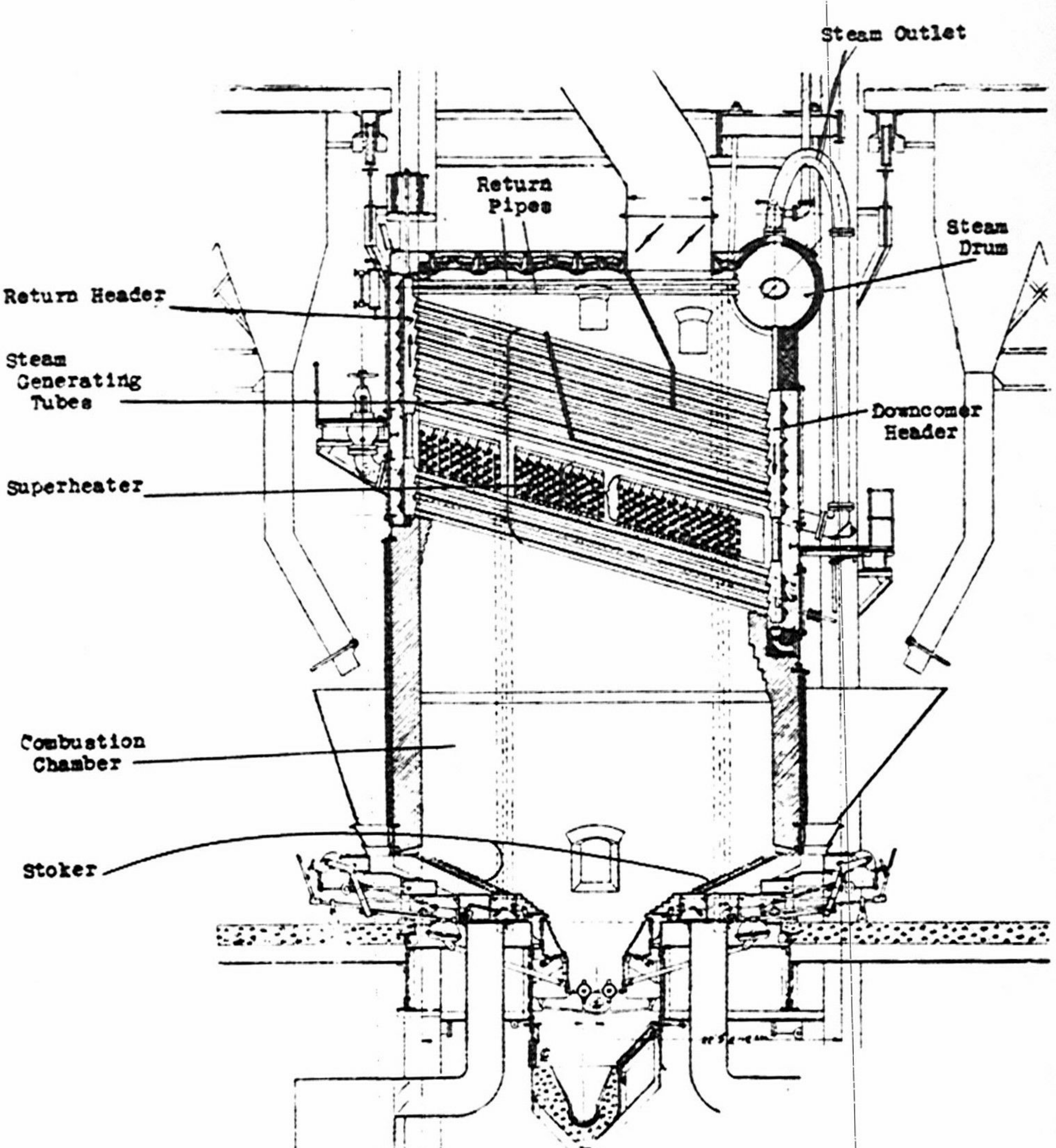
There is a connection at the top with tubes 22 at the left end. I mean that these tubes 24 are connected to the right-hand ends of tubes 22. You can't get water through those tubes because there is nothing to cause a flow downward through tubes 22. The water would have to flow out of the steam drum 21 into the upper end of the header 23 in order to supply water through 22 down to the top of header 24. Now, that is going contrary to the flow which is set up by the heat from the burning gases, and which is determined by the inclination of the tubes 22.

The direction of flow through that group of tubes 33 in the side walls which are at the right of the bridge wall 20 in my opinion would be upward. That is, it would try to go upward; but it would not go upward as in the horizontal tubes, if there were free flow in the horizontal tubes. In other words, there would be no definite circulation in those
tubes 33, because the water cannot get into the tubes
108 if the line is carried as *as* shown on the Griffiths pat-
ent. The top of the tubes would be steam bound. Or, conceding that the water could get up, you have got the same amount of heat on adjacent tubes; so that the tendency is for the water to rise in each one of those tubes; not to go downward. There is no differential of pressure there that would tend to bring the water down in one tube and allow it to go up in the other tube.

In Fig. 1, there in the diagram against the blackboard, if there is heat applied on both sides, and the heat on one side is considerably greater than on the other, there will be circulation.

The baffle 26, shown in Griffiths, which is made up of tubes 41, deflects the gases toward the right-hand side of this boiler furnace so that you would get beyond the bridge wall 20 a very high temperature.

Pl. Ex. 1



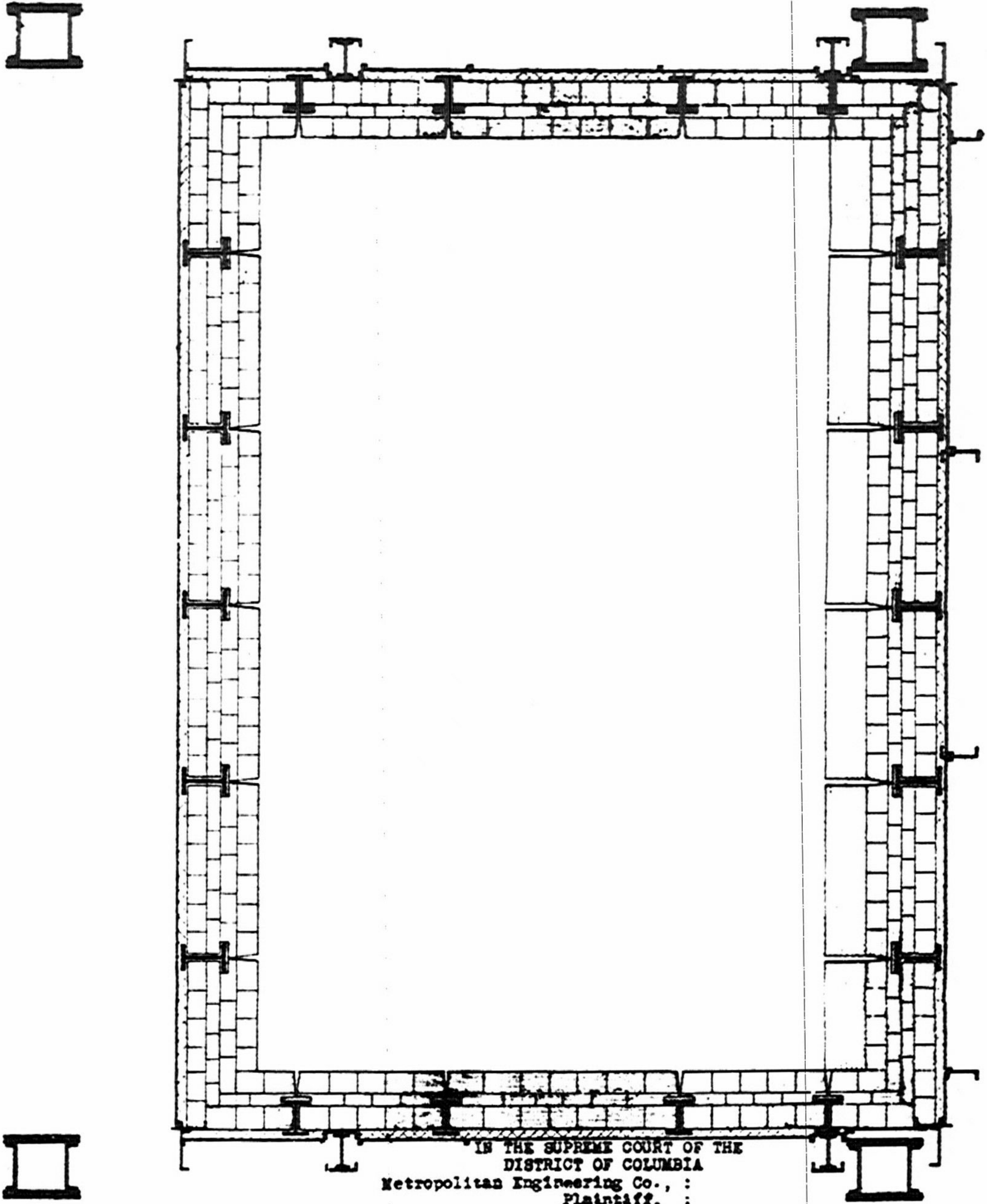
CROSS SECTION OF BOILERS 11-43, HELL GATE STATION

Installed in 1921

IN THE SUPREME COURT OF THE
DISTRICT OF COLUMBIA

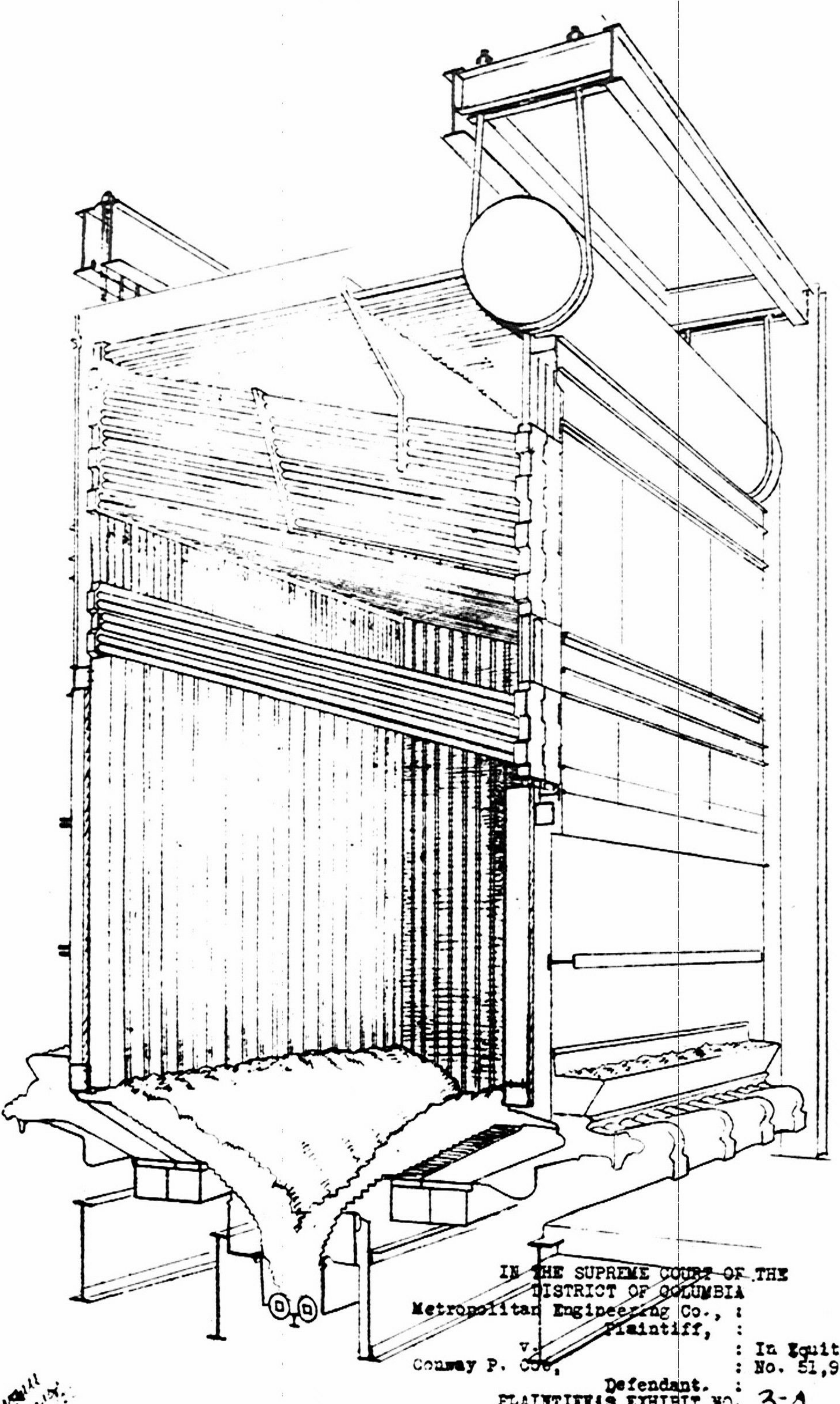
Metropolitan Engineering Co., :
Plaintiff, : In Equit
v. : No. 51,
Conway P. Coe, :
Defendant. :

PLAINTIFF'S EXHIBIT NO. 1



IN THE SUPREME COURT OF THE
DISTRICT OF COLUMBIA
Metropolitan Engineering Co., :
Plaintiff, :
v. : In Equity
Conway & Fee, : No. 51,977
Defendant. :

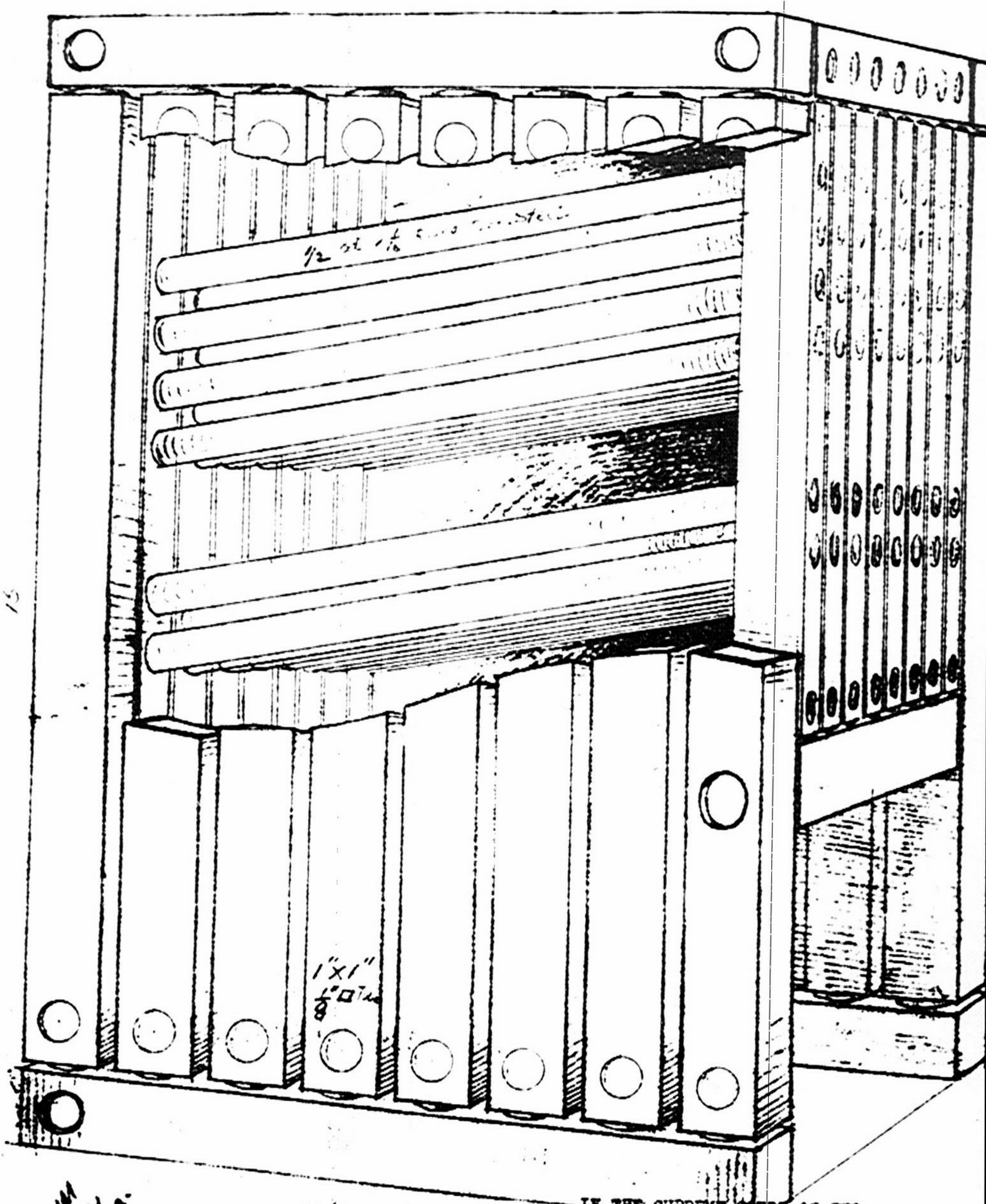
PLAINTIFF'S EXHIBIT NO. 2



IN THE SUPREME COURT OF THE
DISTRICT OF COLUMBIA

Metropolitan Engineering Co., Plaintiff,	:	
v.	:	In Equity
Conway P. Coe,	:	No. 51,977
Defendant.	:	

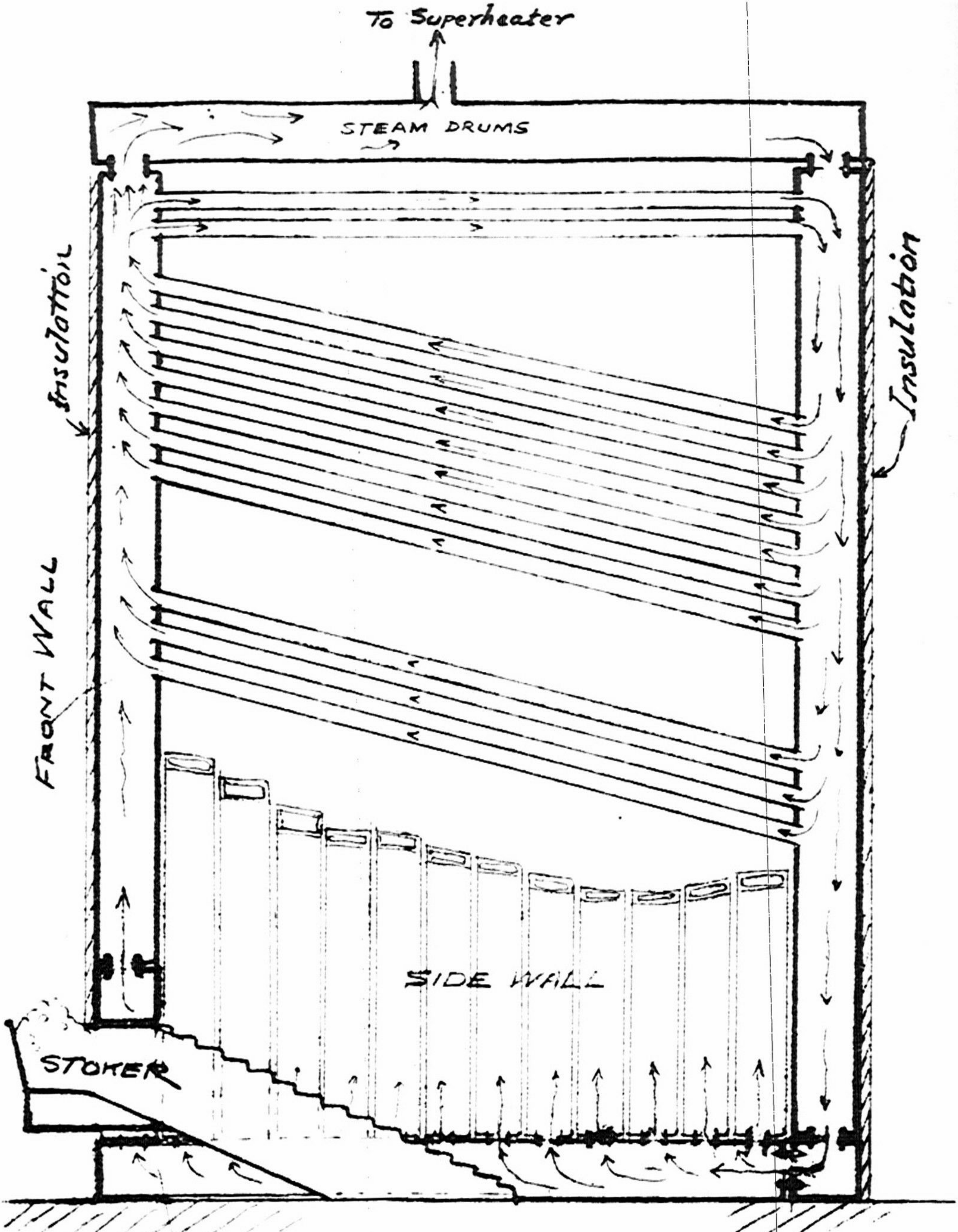
PLAINTIFF'S EXHIBIT NO. 3-1



IN THE SUPREME COURT OF THE
DISTRICT OF COLUMBIA

Metropolitan Engineering Co., :
Plaintiff, :
"F"
v. : In Equity:
Conway P. Coe, : No. 51,977
Defendant. :

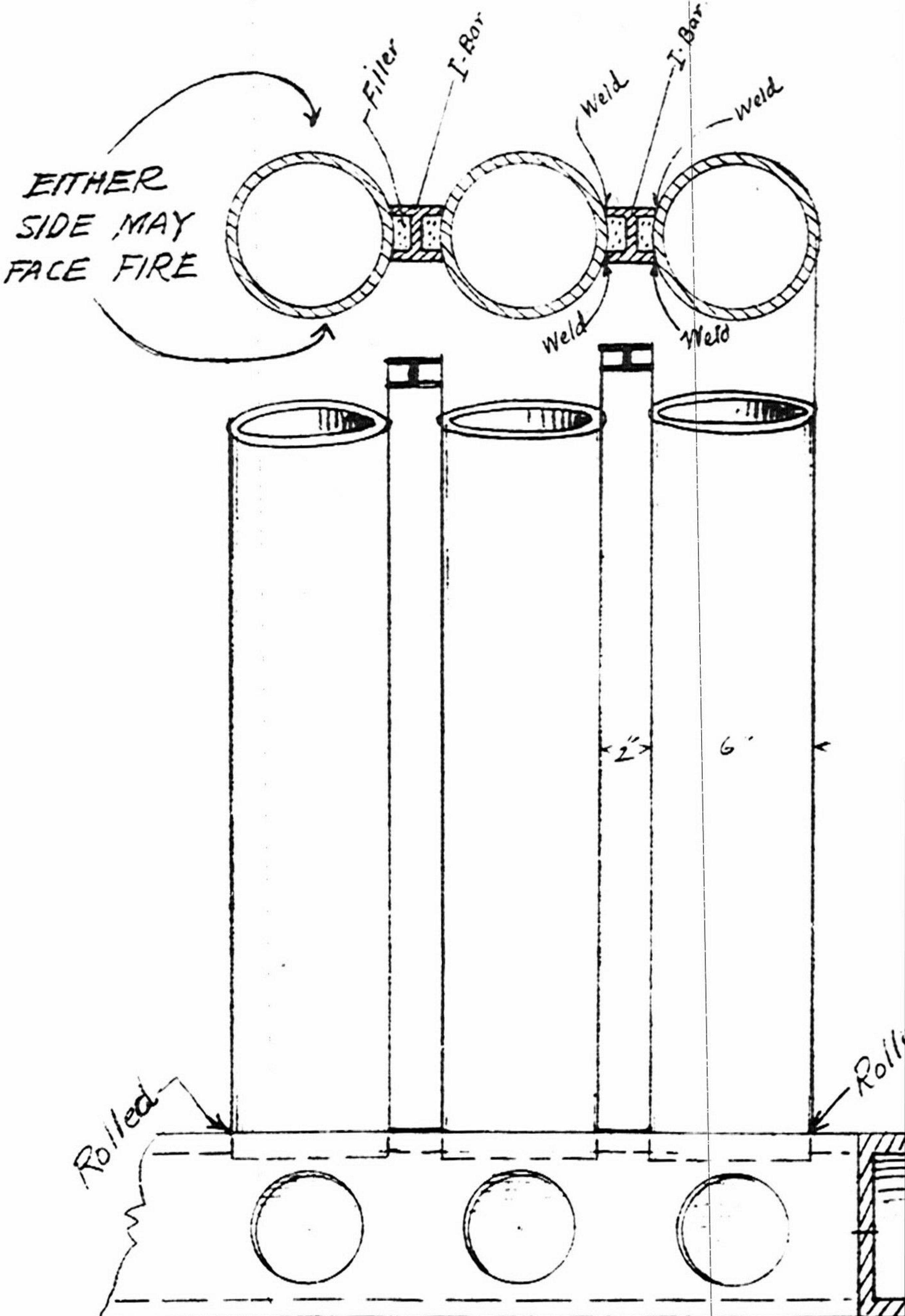
PLAINTIFF'S EXHIBIT NO. 3-B



CIRCULATION DIAGRAM.

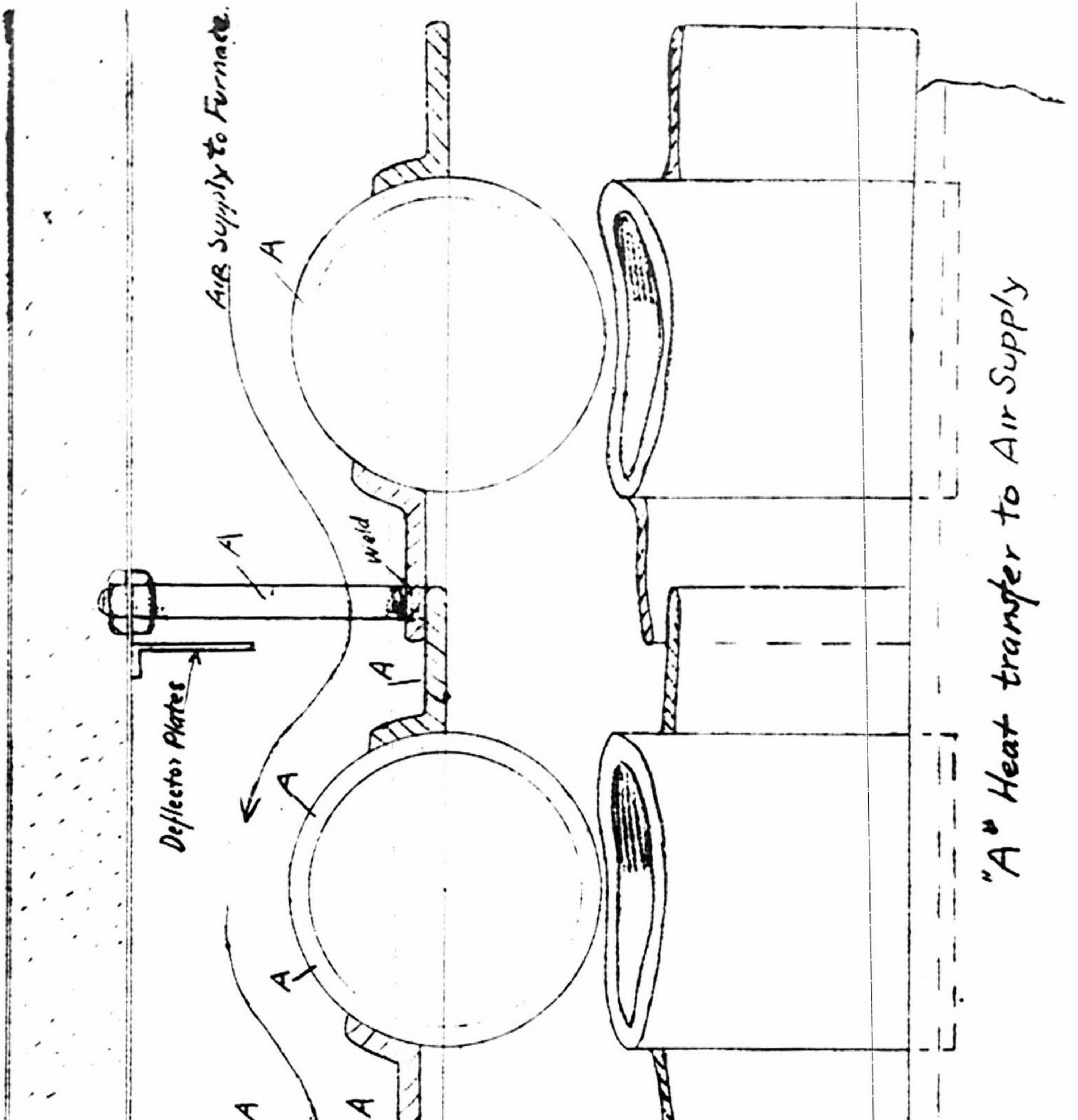
IN THE SUPREME COURT OF THE
DISTRICT OF COLUMBIA
Metropolitan Engineering Co., : Plaintiff, :
v. : In Equity.
Conway P. Coe, : No. 51,877
Defendant.
PLAINTIFF'S EXHIBIT NO. 3-C

Mar 13/23 -

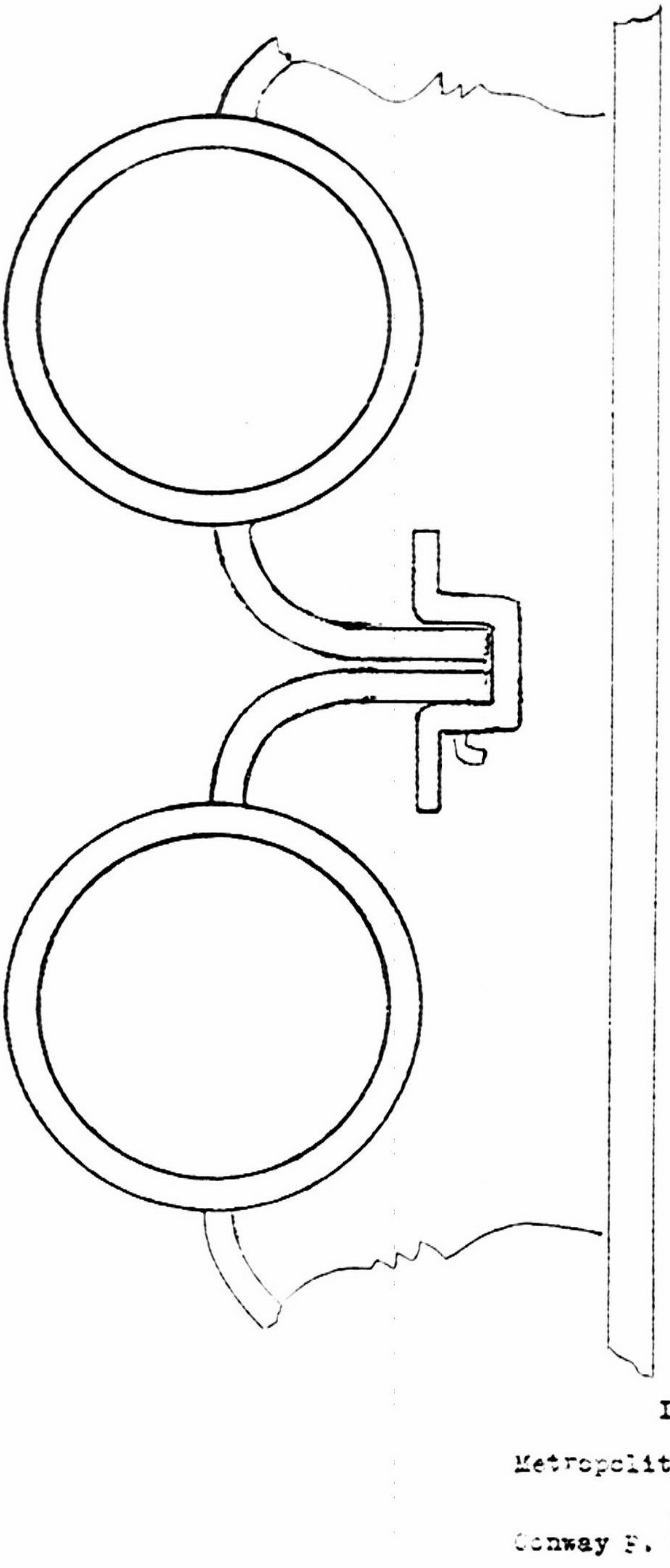


IN THE SUPREME COURT OF THE
DISTRICT OF COLUMBIA
Metropolitan Engineering Co.,:
Plaintiff, :
v. : In Equ
Conway P. Coe, : No. 51
Defendant. :
PLAINTIFF'S EXHIBIT NO. 3-D

Wall - Mar 20/23



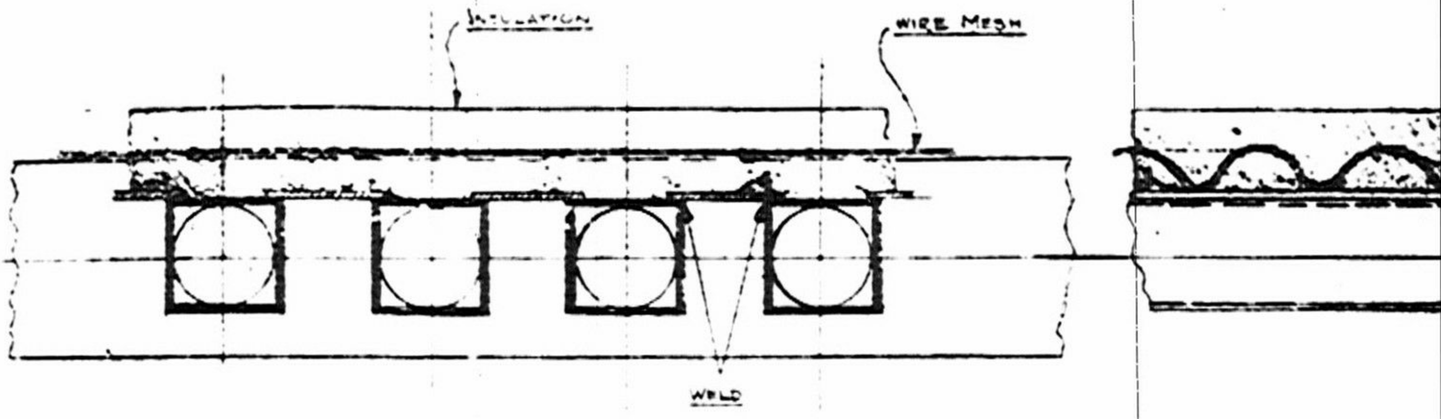
IN THE SUPREME COURT OF THE
DISTRICT OF COLUMBIA
Metrolpolitan Engineering Co. :
Plaintiff. :
v. : In Equity
Conway P. Coe, : No. 51,9
Defendant. :
PLAINTIFF'S EXHIBIT NO. 3-E



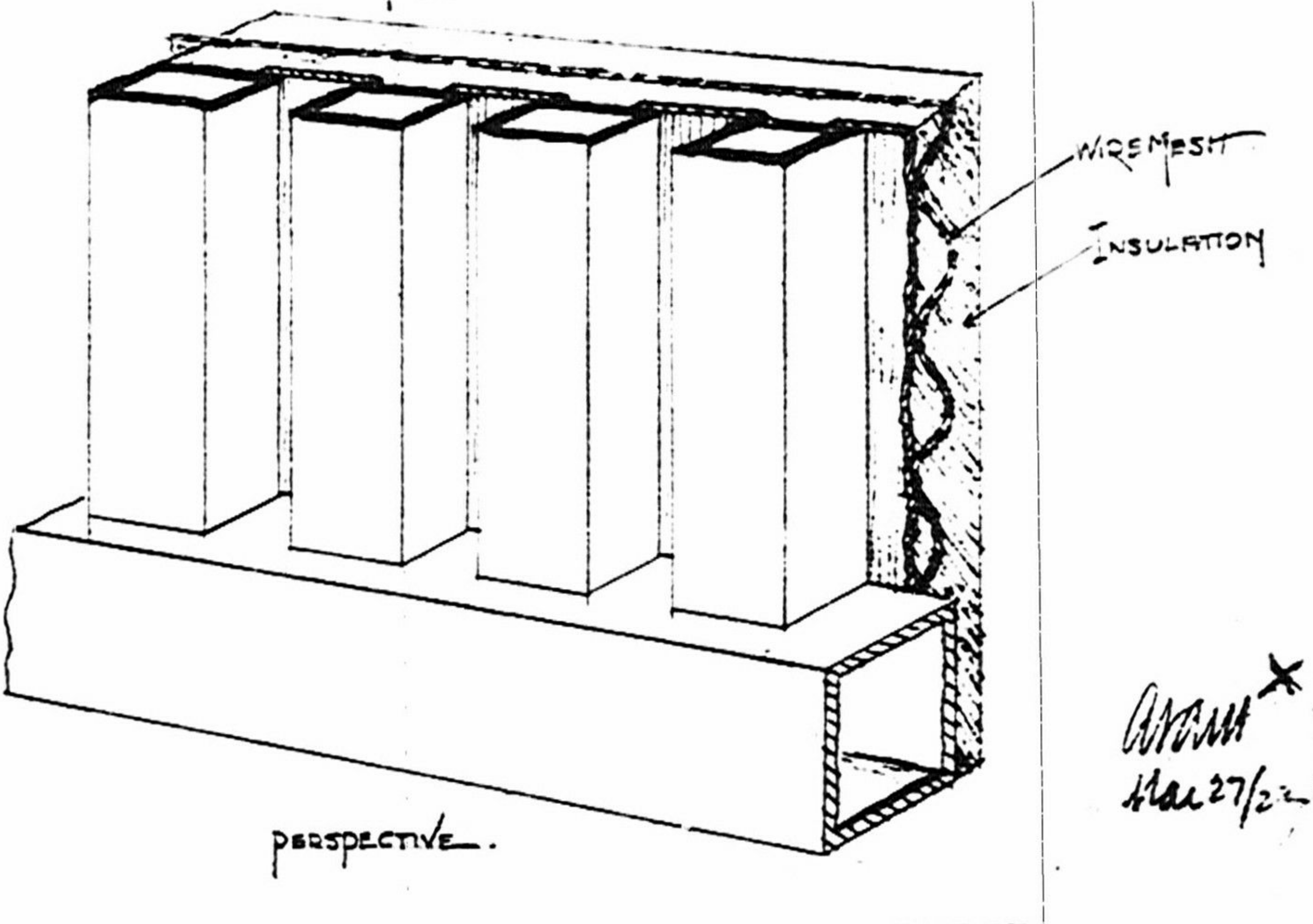
IN THE SUPREME COURT OF THE
DISTRICT OF COLUMBIA

Metropolitan Engineering Co., Plaintiff,	:
v.	: In Equi
Conway F. Coe, Defendant.	: No. 51,9

PLAINTIFF'S EXHIBIT NO. 3-F



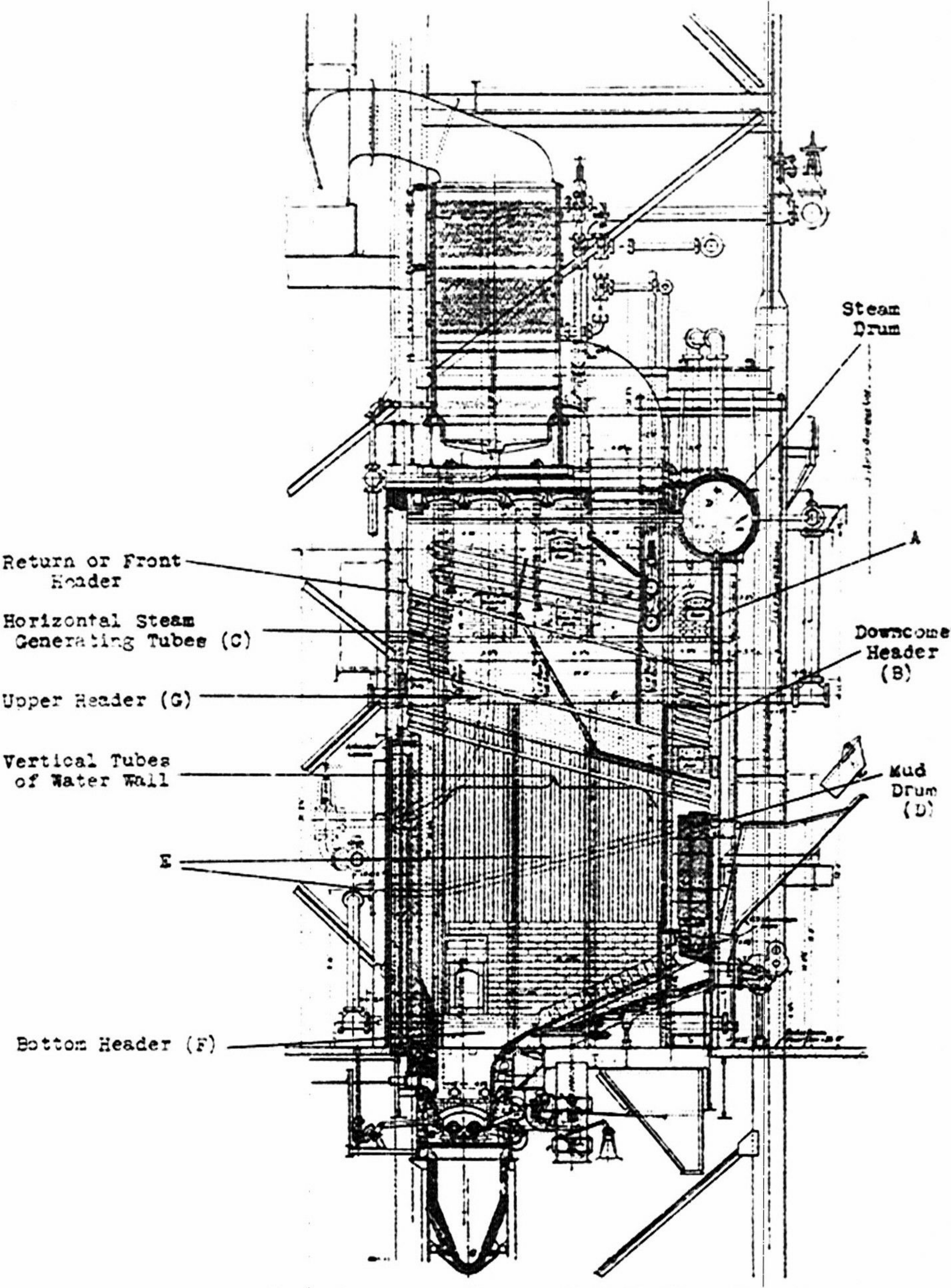
PLAN



PERSPECTIVE.

Mar 27/22

IN THE SUPREME COURT OF THE
DISTRICT OF COLUMBIA
Metropolitan Engineering Co., :
Plaintiff, :
v. : In Equity
Conway P. Coe, : No. 51,977
Defendant. :
PLAINTIFF'S EXHIBIT NO. 3-S



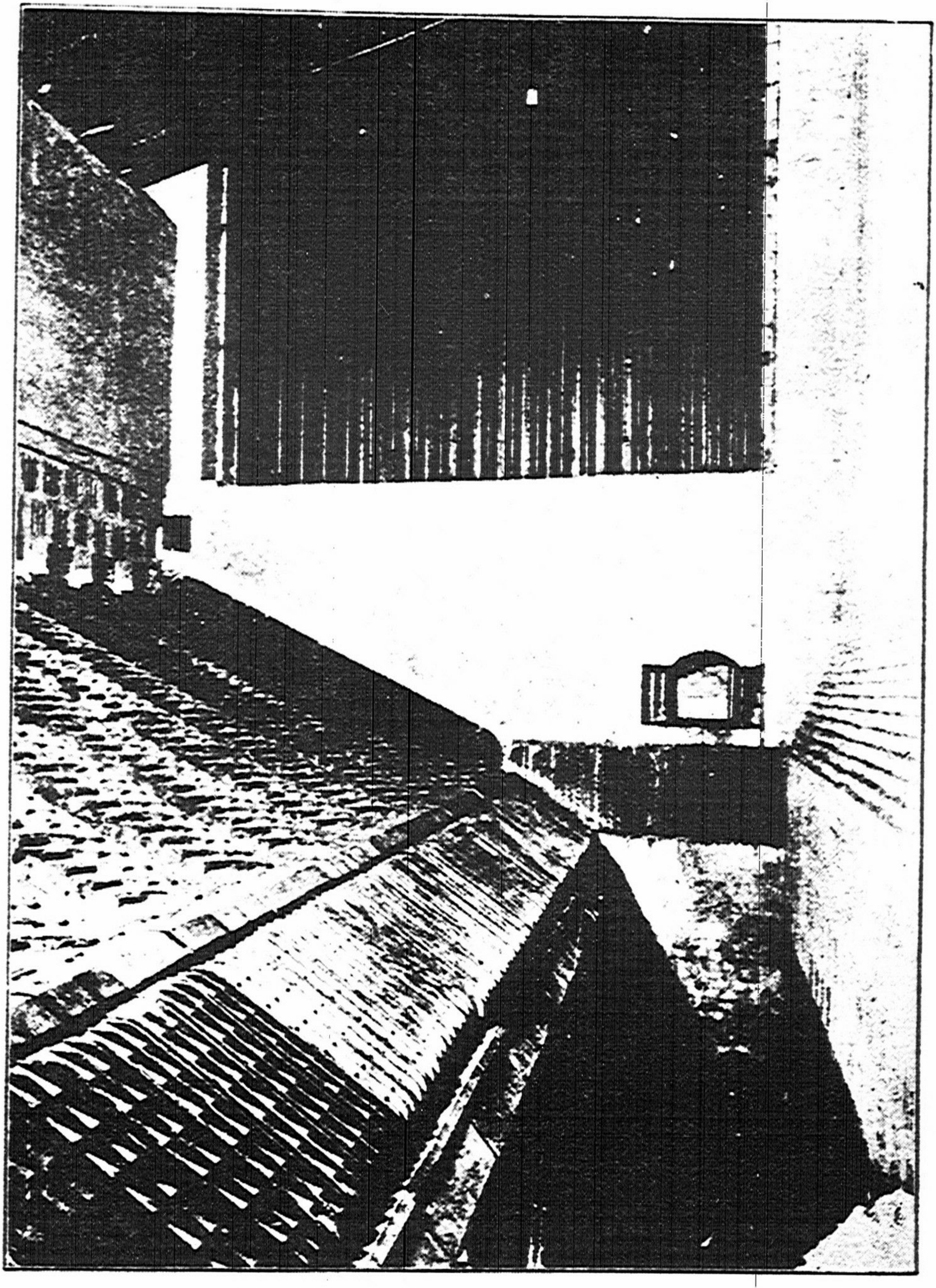
CROSS SECTION OF BOILERS 51-52-53, HELL GATE STATION

IN THE SUPREME COURT OF THE
DISTRICT OF COLUMBIA
Metropolitan Engineering Co., :
Plaintiff, : In Equity
v. : No. 51,977
Conway P. Coe, :
Defendant :
PLAINTIFF'S EXHIBIT NO. 4

IN THE SUPREME COURT OF THE
DISTRICT OF COLUMBIA

Metropolitan Engineering Co., : Plaintiff, :
v. : In Equity No. 51,977
Conway P. Coe, : Defendant. :

PLAINTIFF'S EXHIBIT NO. 5



INTERIOR OF BOILERS 51, 52, 53, HELL GATE STATION

There is absolutely nothing in the Griffiths patent that indicates that he intended to have the water come down at the right-hand side of the tubes 33 of this group and to go up in the left-hand tubes of that group. It is very clear from reading the Griffiths patent that what he intended was that the water should go down through one tube and up through the next tube to it; that is, go down through the tube which has its mouth below the water level, and come up through the next tube, which delivers above the water level. That is very clear from lines 75 and 76—"alternately above and below the water line thereof."

In my opinion that could not be.

Recross-examination:

Griffiths doesn't specifically state that the water is to go down the submerged tube and steam come out of the exposed tube. But it is very clear to an engineer reading this patent that that was the way Griffiths intended his boiler should work.

(Here follow Plaintiff's exhibits, side folios 109-119.)

120 In the Supreme Court of the District of Columbia.

In Equity.

No. 51,977.

METROPOLITAN ENGINEERING CO., Plaintiff,

v.

CONWAY P. COE, Defendant.

PLAINTIFF'S EXHIBIT NO. 7.

Agreement between Thomas E. Murray, a resident of Brooklyn, County of Kings and State of New York, and International Combustion Engineering Corporation a corporation of Delaware, hereinafter referred to as International Corporation:

Whereas, said Murray and certain associates and associated companies are the owners of numerous Letters Patent and pending applications for patent shown on the attached list marked Exhibit A and said International Corporation desires to use some or all of the inventions covered thereby, and particularly those pertaining to or useful in connection with the subject matter of Paragraph 1 hereof.

Now, therefore, in consideration of the foregoing and of the following agreements, said parties have agreed as follows:

1. Said Murray for himself and associates and associated companies as to whose patents he has the necessary power, grants to International Corporation the exclusive right and license throughout the world to make, use and sell the inventions covered by the said patents and applications insofar as the same apply to, or are employed in the building or operating of stationary power plants and parts thereof, and particularly in combustion furnaces, boilers, superheaters, economizers, air heaters, side wall constructions and the fuel burning field, all in connection with stationary power plants, and the same right and license as to any other improvements which he, his associates and associated companies may have, make or acquire.

It is further understood and agreed by the parties that valves, pipe fittings as such, radiators and house heaters and house boilers are specifically excluded from the license herein given.

2. International Corporation agrees to pay to Murray the following royalties on construction in the field above granted, as follows:

(a) On construction hereafter applied by it to any boiler installation in existence at the time of such application, a royalty of five (5%) percent of its selling price to its customers on the entire construction applied in which
121 any of said inventions are used.

(b) On new boiler installations in whole or substantial part employing any of said inventions, a royalty of fifty (50) cents per horse-power. For example, such a boiler having 2000 rated horse-power would carry a royalty of One Thousand ($1,000.00) Dollars.

The minimum amounts of royalty to be paid by International Corporation shall be, for the year 1924 Twenty-Five Thousand ($25,000.00) Dollars; for the years 1925 and 1926, Fifty Thousand ($50,000.00) Dollars each year; thereafter for twelve years, Seventy-five Thousand ($75,000.00) Dollars for each year.

3. At the end of the above period, expiring December 31, 1938, International Corporation shall have the right to renew their agreement for the life of any patents in existence at that time, at the same rate of royalty and with a minimum guarantee of Seventy-Five Thousand ($75,000.00) Dollars per year. Such renewal shall be by notice in writing to said Murray before December 31, 1938, and unless renewed, this agreement shall terminate December 31, 1938.

4. Murray agrees to defend any suits for infringement of patent of others by apparatus made in accordance with any of said inventions, and made, sold or installed through International Corporation, International Corporation to have the right to take part by counsel of its own selection. If the final outcome of such a suit shall be to seriously diminish the value of this license, the parties mutually agree that they will then arbitrate the question of re-forming this agreement to meet the changed conditions fairly to both parties.

5. International Corporation shall have the right to prosecute suits to prevent others from infringing any of the patents above referred to and any patents granted on applications above referred to where such infringements occur in connection with aforesaid power plants. In any such suit, Murray shall have the right to take part by counsel of his own selection.

122 6. It is understood and mutually agreed between the parties hereto, that there will be, as far as they can secure it, mutual cooperation between Murray, his associates and associated companies on the one hand, and International Corporation, its associates and associated companies on the other hand.

7. International Corporation shall have also the unqualified right to grant sub-licenses to its controlled, associated and subsidiary companies, and to grant sub-licenses to others with the approval of Murray, provided that it shall at the same time notify Murray and guarantee the royalties and other obligations due from such sub-licensee. If Murray shall fail after request to approve the grant of such sublicense, the matter shall be arbitrated. This involves no increase in minimum royalties guaranteed.

8. International Corporation agrees to keep books showing all installations made, sold and installed by it, in which the aforesaid inventions and improvements have been utilized and the selling price and any other consideration re-

ceived therefor, the same to be open to inspection of Murray or his representatives at any reasonable time. International Corporation agrees to pay the royalty quarterly and to render a report at the end of each quarter listing the constructions involved and the royalties due.

9. If at any time the patent protection realized under patents owned and controlled by Murray together with those owned and controlled by International Corporation shall not afford the measure of protection to be reasonably expected in view of the prior development of the art, or if such protection should become impaired substantially below that standard, the question of whether the rate of royalty and the minimum royalty shall be reduced and the amount of reduction, if any, shall be determined by arbitration.

10. If at any time International Corporation shall fail to carry out its obligations under this agreement, or shall delay an unreasonable length of time in doing so, Murray shall have the right to terminate the license herein
123 granted by notice in writing to that effect, and such
termination shall not relieve the International Corporation from prior obligations incurred by it.

In case of dispute as to the requirements of compliance, this shall also be arbitrated.

This agreement shall be binding upon and shall enure to the benefit of the parties hereto and their heirs, assigns, successors and legal representatives.

In witness whereof the parties have executed this agreement at New York City, New York, this 25th day of March, 1924.

INTERNATIONAL COMBUSTION ENGINEERING CORPORATION,
By J. V. SANTEY,
Vice President.
THOMAS E. MURRAY.

Attest:
[Name illegible],
Asst. Secretary.

O K as to form.
H. L. L.

3/25/24.

124 State of New York,
County of New York:

Personally appeared before me this 25th day of March, 1924, Thomas E. Murray, known to me and known by me to be the person who executed the foregoing agreement, and acknowledged that he executed the same for the purposes therein stated.

FRANCIS M. FITZGERALD,
Notary Public.

Notary Public, Kings Co. No. 275, Reg. No. 5071.
Cert. filed in N. Y. Co. No 241, Reg. No. 5201.
Commission expires March 30th, 1925.

State of New York,
County of New York:

Personally appeared before me this 25th day of March, 1924, J. V. Santey, known to me and known by me to be the same person who executed the foregoing agreement, and acknowledged that he executed the same on behalf of International Combustion Engineering Corporation, and for the purposes therein stated, and that he was authorized so to do by the Board of Directors of said Corporation.

WALTER J. WAKEFIELD,
Notary Public.

Notary Public, New York County No. 485.
New York County register No. 5476.
Certificate filed Bronx County No. 64.
Bronx County Register No. 287.
My commission expires March 30, 1925.

125 Exhibit A.

List of Patents and Pending Applications Referred to in Agreement Between Thomas E. Murray and International Combustion Engineering Corporation.

Patents.

1,001,049	Process of Welding Sheet Metal.
1,006,103	Method of Making Ball Bearing.
1,015,482	Electric Welding Machine.
1,050,827	Timer for Electric Welding Machine.
1,061,375	Electric Welding.

1,061,376	Electrode for Electric Welding Machines.
1,061,377	Electric Welding System.
1,061,378	Electric Welding Machine.
1,078,675	Electrical Welding Apparatus.
1,115,943	Method of and Apparatus for Electric Welding and Article.
1,145,642	Apparatus for Electric Welding.
1,153,384	Electric Welding Apparatus.
1,156,426	Apparatus for Electric Welding.
1,172,301	Electrical Welding.
1,172,302	Electrical Welding.
1,177,260	Apparatus for Electric Welding.
1,180,096	Apparatus for Electric Welding.
1,183,195	Timing Apparatus for Electric Welding and the Like.
1,183,196	Timing Apparatus for Electric Welding.
1,183,264	Method of and Apparatus for Electric Welding.
1,186,222	Method of Electrical Welding.
1,187,543	Electric Welding Machine.
1,189,856	Method of Localizing the Bur at Electrical Butt or Edge Welded Joints.
1,196,473	Electrical Welding.
1,206,885	Method of Electrical Edge Welding.
1,206,890	Method of Electric Spot Welding.
1,207,915	Timing Mechanism for Electric Welding.
1,212,804	Method of Flanging the end of a Metal Tube.
1,212,869	Electric Welding Machine.
1,215,964	Electric Welding Machine.
1,215,965	Method of Flanging the End of a Metal Tube.
1,215,966	Means for Electrically Welding Tubes in Sleeves.
1,215,967	Electrically Welded Tube & Flange Plate.
1,219,135	Method of Flanging the End of a Metal Tube.
1,219,136	Electrical Welding Apparatus.
1,219,137	Electrical Welding Apparatus.
1,219,138	Electrical Welded Tube & Flange.
1,219,139	Method of Electrically Welding the End of a Tube Within a Sleeve or Socket.
1,220,770	Method of Electrical Welding.
1,220,772	Method of Welding & Treaded Tube in a Sleeve or Ferrule.
1,220,773	Method of Producing Solid Ribs on Sheet Metal Tubes.

1,220,774	Method of Electrical Welding.
1,220,776	Method of Electric Welding.
1,220,848	Electric Welding Apparatus.

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1,223,091	Method of Making Hollow Metal Objects by Electrical Welding.
1,223,092	Electric Welding Apparatus.
1,227,179	Coupling for Flanged Tubes or Pipes.
1,230,357	Device for Controlling Energy Delivered to Welding Electrodes.
1,233,688	Electric Welding Machine.
1,233,689	Process of and Apparatus for Electrically Making Holes in Metal Blocks for Plate.
1,233,690	Process of and Apparatus for Electrically Making Holes in Metal Blocks for Plates.
1,233,691	Process of and Apparatus for Electrically Dividing Metal Plates or Blocks.
1,237,371	Apparatus for Bending Metal Plates.
1,242,380	Apparatus for Electrically Making Cup shaped Projections in Metal Plates.
1,242,581	Method of and Apparatus for Electrically Making Openings in Metal Plates.
1,252,142	Method of Electric Welding.
1,252,143	Electric Welding Machine.
1,252,144	Process of and Apparatus for Welding Metal Bodies and for Annealing said Bodies at the Welded Joint.
1,252,145	Apparatus for Electric Welding.
1,252,146	Method of and Apparatus for Electrically Welding Plates or Bars together.
1,252,147	Method of Electrically Making Openings of desired Configuration in Metal Plates.
1,252,148	Method of and Apparatus for Electrically Dividing Metal Plates.
1,252,289	Method of Producing Integral Projections on Metal Plates.
1,252,290	Method of Localizing and Eliminating Imperfections in Electrically Welded joints.
1,259,270	Method of Making Welded Metal Rings.
1,259,271	Electric Welding.
1,259,272	Method of and Apparatus for Electrical Welding.
1,259,273	Method of Electrical Butt-welding.

1,259,274	Electric Welding Machine.
1,267,251	Method of Making Metal Rings.
1,267,254	Electric Welding Machine for Making Metal Rings.
1,267,256	Method of and Apparatus for Electric Welding.
1,267,259	Method of and Apparatus for Electric Welding.
1,270,045	Method of Welding the Butt end of a Tube to a plate of thin metal having an opening.
1,273,524	Coupling for Flanged Tubes or Pipes.
1,278,193	Process of Electric Welding.
1,286,064	Apparatus for Truing and Removing the Bur from Electrically Welded Work.
1,290,996	Electric Welding Machine.
1,290,997	Method of and Apparatus for Electric Welding.
1,291,600	Header for Water Tube Boilers.
1,291,601	Method of Electric Welding.
1,293,867	Electric Welding and Product Thereof.
1,293,868	Process of Making Headers for Water Tube Boilers.
1,293,871	Pipe Coupling and Method of Producing Same.
1,293,872	Method of Electrically Uniting Metal Bodies.
1,295,568	Process for the Refining of Metals.
1,295,570	Welding Electrode.
1,295,787	Electric Welding Machine.
1,302,412	Pipe Connection and Method of Making Same.
1,302,413	Method of Electric Welding.
1,303,575	Welding Electrode.
1,310,130	Method of Producing Metal Tubes.
1,316,383	Method of Electrical Welding.
1,316,384	ditto.
1,316,385	“
1,316,386	Method of Uniting Metal Rods to Metal Plates.
1,320,893	Method of Truing and Removing Burs from Electrically Welded Work.

1,320,894	Electric Welding Apparatus.
1,320,895	ditto.
1,320,896	Method of Controlling Electric Welding Machines.
1,320,897	Apparatus for Electrical Welding.
1,329,135	Method of Electric Welding.
1,329,136	ditto.
1,332,563	Method of Electric Welding and Product Thereof.

1,333,273	Electric Welding.
1,333,274	Apparatus for Electrically Welding the Sections of Hollow Objects.
1,333,275	Metal Incased Tube and Method of Producing the Same.
1,339,966	Method of Producing a Rib on an Electrically Welded Joint.
1,339,967	Method of Electrically Welding Metal Bodies.
1,339,968	Method of Electrical Welding.
1,339,969	ditto.
1,339,970	Method of Producing Longitudinal Ribs on the exteriors of Tubes.
1,339,971	Method of Electrical Welding.
1,339,972	ditto.
1,350,829	Method of Making a Plurality of Like Tubular Objects.
1,350,831	Method of Electric Welding.
1,350,832	Closure of Openings in Boiler Headers.
1,350,833	Process of Electrically Welding Transverse Plates to Tubes.
1,363,156	Method of Electrically Welding Together the Edges of Thin Metal Plates.
1,363,157	Electrically Welded Tube and Method of Making the Same.
1,363,158	Electrically Welded Tube and Method of Making the Same.
1,363,159	Electrically Welded Tube.
1,363,160	Method of Inclosing Tubes within Tubes.
1,363,161	Method of Uniting Metal Plates.
1,368,045	Method of Producing a plurality of Objects of Sheet Metal.
1,370,987	Apparatus for Electrically Welding Plates.
1,382,193	Machine for Cutting Off Fins from Electrically Welded Work.
1,382,220	Circulation Tube for Water Tube Steam Boilers.
1,399,307	Electrode for Electrical Welding.
1,420,735	Welding Articles with Flange.
15,466	Method of Electric Welding.
1,438,545	ditto.
1,439,480	Forming Flanges on Tubes.
1,467,792	Uniting Metal Parts.

128 Pending Applications.

Serial No.	Title.
573,928	Boilers and Method of Manufacture.
617,669	Hydraulic System for Handling Ashes and the Like.
632,187	Sectional Boilers.
633,407	Hollow Articles and Method of Making the Same.
633,611	Hollow Structures and Method of Making the Same.
642,427	Boilers.
642,725	Boilers.
644,838	Apparatus and Method for Producing Pulverized Coal, Stone and the Like.
645,017	Heat Exchangers.
645,018	Heat Interchangers.
652,659	Utilizing Waste Heat.
674,617	Pulverizing Coal or the Like.
678,402	Pulverizing Coal or the Like.
673,654	Multiple Pressure Steam Installations.
678,443	Boiler Construction.

And any corresponding foreign patents and applications.

129 In the Supreme Court of the District of Columbia.

In Equity.

No. 51,977.

METROPOLITAN ENGINEERING CO., Plaintiff,

v.

CONWAY P. COE, Commissioner of Patents, Defendant.

PLAINTIFF'S EXHIBIT No. 8.

Modifying Agreement.

Whereas, by agreement of March 25, 1924 between International Combustion Engineering Corporation on the one hand and Thomas E. Murray on behalf of himself and certain associates and associated companies on the other hand, granted to International Combustion Engineering Corporation certain exclusive rights and licenses relating to inventions for use in connection with stationary power plants "and the same rights and licenses as to any other improvements which he, his associates and associated companies may have, make or acquire"; and

Whereas, it is recognized by the parties to said agreement of March 25, 1924 that the clause above quoted may under some circumstances be inequitable and tend to discourage the making or acquiring of further improvements by said Murray, his associates and associated companies; and

Whereas, at the time of making said agreement of March 25, 1924 there was not in existence the product now known as the C. E. C. steam generator; and

Whereas, the C. E. C. steam generator is sold and rated upon a different basis from the mode of rating boilers of the standard type such as Babcock & Wilcox, Springfield, Sterling and Heine and so forth (it being expressly understood that the C. E. C. steam generator is not a boiler of the standard type).

Now, therefore, in view of the foregoing and in order to clarify certain ambiguities in respect to said identified agreement dated March 25, 1924, it is hereby understood and agreed as follows:

That, the class of invention contemplated by the parties as coming within the purview of the agreement of March 25, 1924 is set forth in the following words of section 1 of said contract, to wit:

130 "and particularly in combustion furnaces, boilers, superheaters, economizers, air heaters, side wall constructions and the fuel burning field, all in connection with stationary power plants,"

And that, improvements and inventions of this class were also contemplated as coming under the provisions of said contract of March 25, 1924,

And that as to all other improvements or inventions, it is agreed that they shall be submitted to International Combustion Engineering Corporation for acceptance within six months after the date of submission at a royalty to be agreed upon, which royalty in the absence of an agreement shall be fixed by arbitration. If six months is not ample time in any given case, a second six months' period shall be granted for acceptance on the written request of International Combustion Engineering Corporation. It is also agreed that any royalties paid under this clause shall apply to the minimum royalties of said contract of March 25, 1924.

That, in respect to section 2, paragraph (b) thereof which reads as follows:

> (b) On new boiler installations in whole or substantial part employing any of said inventions, a royalty of fifty (50¢) cents per horse-power. For example, such a boiler having 2,000 rated horse-power would carry a royalty of One Thousand ($1,000.00) Dollars

the same be amplified to read:

> (b) On new boiler installations in regard to the standard type such as Babcock and Wilcox, Springfield, Sterling, Heine and so forth in whole or substantial part employing any of said inventions, a royalty of fifty (50¢) cents per horse-power, for example, such a boiler having 2,000 rated horse-power, namely, 20,000 square feet of heating surface would carry a royalty of One Thousand ($1,000.00) Dollars.

and

That, in said section 2 and immediately following said paragraph (b) there be inserted the following as paragraph (c).

131 (c) On steam generating boilers, other than boilers of the standard type, referred to in Section 2, paragraph (b) above, in whole or in part employing any of said inventions, a royalty of Forty (40¢) cents for each 34.5 pounds of steam evaporated per hour from and at 212° F. For example, a steam generator of 100,000 pounds equivalent evaporation per hour would carry a royalty of One thousand, one hundred and fifty-nine dollars and forty-two cents ($1,159.42) computed by dividing 100,000 by 34.5 and multiplying the quotient by Forty (40¢) cents, giving as the result, the royalty specified. It is understood that the amount of royalty specified in this paragraph (c) is to be in force for the calendar year of 1926 and is open to adjustment at the end of each year, and at the end of each succeeding year, during the life of the agreement if such

an adjustment seems advisable or necessary, it being understood that by such adjustment the royalty shall not be less than Thirty (30¢) cents for each 34.5 pounds of steam evaporated per hour from and at 212° F., or greater than Fifty (50¢) cents for each 34.5 pounds of steam evaporated per hour from and at 212° F.

In witness whereof the parties have executed this modifying agreement at New York City, New York, this 8th day of March, 1926.

INTERNATIONAL COMBUSTION ENGINEERING CORPORATION,
By J. V. SANTEY,
Vice-President.
THOMAS E. MURRAY.

Attest:
[Name illegible],
Assistant Secretary.

Sworn to before me this 8th day of March, 1926.
K. M. RICHARDSON.

132 In the Supreme Court of the District of Columbia.

In Equity.

No. 51,977.

METROPOLITAN ENGINEERING Co., Plaintiff,

v.

CONWAY P. COE, Defendant.

PLAINTIFF'S EXHIBIT No. 9.

Murray Water Wall Installations Reported by International Combustion Engineering Corporation and Sold Before Receivership on New Boiler Installations.

Year.	Customer.	Make of Boiler.	No.	Horse power.
1924	Union Elec. Lt. & Pr. Co	B & W	1	1801
"	Staten Island Edison Co	Connelly	2	2730
"	United Elc. Lt. & Pr. Co.	Springfield	3	4770
"	Maxwell Motors Co	Stirling	1	500
"	A. E. Staley Mfg. Co	Edgemoor	1	897
"	Duquesne Light Co	B & W	3	7941

Year.	Customer.	Make of Boiler.	No.	Horse power.
1925	Frazer Co. Ltd	Badenhausen	2	1280
"	Texas Power & Light Co	B & W	4	7200
"	City of Detroit	B & W	6	5700
"	Utica Gas & Electric Co	Connelly	4	6440
"	St. Lawrence Paper Mills	B & W	1	618
"	Canadian Inter. Paper Co	B & W	4	4064
"	Maxwell Motors Co	Stirling	1	500
"	Union Elec. Lt. & Pr. Co	B & W	2	3602
"	Staten Island Edison Co	Connelly	1	1385
"	Consolidated Gas, Elec. Lt. & Pr. Co	B & W	2	5300
"	St. Antonio L & P Co	B & W	2	3600
"	Canadian Inter. Paper Co	B & W	3	3048
"	Consolidated Gas Co	Springfield	3	1797
"	Southern Power Co	B & W	4	10640
"	Mead Pulp & Paper Co	Stirling	3	3171
"	Atlas Portland Cement Co	Comb. Eng	1	4058
"	Synthetic Ammonia & Nitrates (England)	Thompson	4	5804
"	Ashington Colleries (England)	Stirling	4	2362
"	Glasgow Corp. (Scotland)	B & W	2	1395
"	Pilkingham Bros. (England)	B & W	1	828
"	Holland State Mines	B & W	4	4520
1926	Wisconsin Pub. Service Co	Edgemoor	1	1301
"	New York Edison Co	Springfield	6	9300
"	Connecticut Lt. & Pr. Co	Springfield	2	3060
"	Milwaukee Elec. Ry. & Lt. Co.	Stirling	1	2853
"	Phoenix Utility Co	Springfield	2	2026
"	Phoenix Utility Co	Springfield	3	5232
"	Laurentide Pulp & Paper Co	Kidwell	3	2982
"	U S Rubber Co	Comb. Eng	2	5800
"	Commonwealth Edison Co	Comb. Eng	1	3625
"	Solvay Process Co	Comb. Eng	2	8700
"	Boston Elev. Ry. Co	B & W	2	4150
"	Metropolitan Power Co	Connelly	1	1471
"	Kentucky Elec. Power Co	Stirling	1	834
"	Potomac Elec. Power Co	B & W	4	5480
"	New York Steam Corp	Ladd	3	3201
"	Lincoln Oil Ref. Co	Vogt	3	1500
"	Milwaukee Elec. Ry. & Lt. Co.	Edgemoor	1	1043
"	Fort William Paper Co	Stirling	1	1280
"	National Enameling & Stamping Co.	Comb. Eng	2	7000
"	N. Y., N. H., & H. Railroad	Comb. Eng	2	5833
"	A. E. Staley Co	Comb. Eng	1	3630
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"	Bethlehem Steel Co	Comb. Eng	2	8750
"	Cannon Mfg. Co	Walsh & Weidner	3	1860
"	Cushnoc Paper Co	Edgemoor	1	624
"	Texas Construction Co	B & W	1	1650
"	New Orleans Pub. Serv. Co	B & W	3	5058
"	Bethlehem Steel Co	Walsh & Weidner	2	2582
"	Kentucky Power Co	B & W	2	600
"	Bogalusa Paper Co	Walsh & Weidner	1	1002
"	Binghampton H. L. & P. Co.	Edgemoor	1	1200
"	International Paper Co	Ladd	4	4080
"	Pressed Steel Car Co	Walsh & Weidner	2	2606
"	Berlin Co	Heine	1	1000
"	Saint Anne Paper Co	Kidwell	3	2460
"	Commonwealth Power Co	Springfield	3	4608
"	Foundation Co. (London)	B & W	5	5016
"	Electricity Supply Comm. (Congella, S. Africa)	B & W	4	2860
"	Societe Financiere de Transports & Industrielle (Belgium)	B & W	8	10196

Year.	Customer.	Make of Boiler.	No.	Horse power.
1926	County of London (England)	B & W	10	16510
"	Shell Mex. Ltd. (England)	B & W	3	2196
"	Municipal Council (Shanghai)	B & W Stirling	2 1	4800
"	Electricite de Strasbourg	Stirling	1	1078
"	Electricite de La Campine (Belgium)	Ladd	4	1938
"	Comp. Parisienne de Distrib d'Electricite (Paris)	Stirling Alsacienne	2 1	5810
1927	Long Island Lighting Co	B & W	2	2542
"	Standard Oil of Indiana	Stirling	8	12236
"	Duquesne Light Co	B & W	3	8304
"	Duquesne Light Co	B & W	2	5556
"	Nashville Ry. & Ltg. Co	Walsh & Weidner	2	2902
"	City of Jacksonville	B & W	3	4500
"	Kansas Power & Light Co	B & W	1	1230
"	Morton Salt Co	C. D	2	1518
"	Sioux City Gas & Elec. Co	Stirling	1	1112
"	New York Steam Corp	Ladd	1	1067
"	New Mexico Power Co	Heine	1	710
"	Nashwaak Pulp & Paper Co	Kidwell	2	1240
"	Carbide & Carbon Chem. Co	Heine	2	1866
"	Bagasse Products Corp	Heine	1	416
"	Maysville Pub. Serv. Co	Heine	1	603
"	Proximity Mfg. Co	Heine	2	1726
"	Amer. Cyanamid Co	Heine	1	773
"	Chrysler Corporation	Heine	1	792
"	Jos. Bancroft & Sons	Edgemoor	2	1024
"	Frazer Ltd	Badenhausen	1	941
"	Kansas City Pr. & Lt. Co	Ladd	3	4548
"	Penn Water Co	Heine	3	1257
"	Louisiana Power Co	Heine	3	4857
"	Kansas City P. & L. Co	Ladd	2	3390
"	Chrysler Corporation	Heine	1	1193
"	Champion Fibre Co	Heine	2	1828
"	Alabama Power Co	B & W	2	6000
"	Pennsylvania Salt Co	Ladd	1	1245
"	University of Chicago	Heine	3	3612

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Year.	Customer.	Make of Boiler.	No.	Horse power.
"	Texas Construction Co., Houston	B & W	1	1650
"	United Elec. Lt. & Pr. Co	Springfield	3	3000
"	Fraser Paper Ltd	Badenhausen	1	941
"	Boro of Wallsall (England)	Thompson	3	2568
"	Perak River Hydro. Elec. (Malay States)	Thompson	3	1614
"	City of Birmingham (England)	B & W	5	10000
"	City of Birmingham (England)	B & W	1	885
"	Soc. d'Electricite de Rosario	B & W	2	1180
"	Taylor Bros. (Manchester, England)	Thompson	2	1480
"	Shanghai Municipal Elec. Department	Stirling	1	1400
"	Union E'Electricite (Paris)	B & W	1	1507
"	Comp. d'Electricite de Marseilles	Stirling	2	1381
"	Comp. d'Electricite de Marseilles	Stirling	2	1381
1928	Potomac Electric Co	B & W	4	5480
"	San Antonio Pub. Serv. Co	Walsh & Weidner	1	1778
"	Allegheny Steam Heat Co	Ladd	2	7340
"	Amtorg Trading Corp. (Leningrad)	Stirling	3	2421
"	American Cyanamid Co	Heine	1	773
"	Consumers Power Co	Walsh & Weidner	2	3400
"	Nekoosa Edwards Paper Co	Stirling	1	834
"	A. E. Staley Mfg. Co	Edgemoor	1	897
"	Miami Copper Co	Heine	4	2880
"	New Jersey Power & Light Co	B & W	2	1964

Year.	Customer.	Make of Boiler.	No.	Horse power.
1928	Whitin Machine Works	Edgemoor	1	624
“	Penick & Ford Ltd	Heine	1	1250
“	Chrysler Corp	Heine	2	1254
“	Chevrolet Motor Co	Heine	2	2080
“	Page Wire & Steel Co	Heine	2	1074
“	St. Lawrence Paper Mills	Kidwell	2	1600
“	DuPont Rayon Co	Stirling	3	2400
“	Chrysler Corp	Heine	1	835
“	Viscose Co	Edgemoor	3	3000
“	Cannon Mills	Heine	1	1353
“	Mengel Co	Vogt	1	860
“	New York Edison Co	Ladd	3	18003
“	New Brunswick Power Co	Kidwell	1	947
“	Mengel Co	Vogt	1	860
“	DuPont Rayon Co	Stirling	3	2400
“	American Cyanamid Co	Heine	1	985
“	Mead Pulp & Paper Co	Stirling	1	1346
“	Chesapeake Corp	Walsh & Weidner	2	1522
“	International Comb. Tar. & Chem. Corp	Heine	2	1578
“	Chrysler Corp	Heine	2	1252
“	Essendale Asylum	Connelly	1	400
“	City of Moose Jaw	Heine	1	601
“	Corp. of Derby	Comb. Eng. Corp.	2	3478
“	Gulf States Paper Corp	Heine	3	3069
“	Corp. of Leeds (England)	Stirling	3	4962
“	Imperial Chem. Industries	LoPulco	6	4810
“	Elec. Supply Commission	B & W	2	1430
“	Hagar Elec. Dept	B & W	2	2640
“	Babcock & Wilcox Ltd	B & W	1	821
“	Corp. of Leicester	LoPulco	3	3067
135				
1928	Perak River Hydro Elec. Power Co	Thompson	1	1053
“	Metropolitan Railway (England)	Tri-Drum	6	5430
“	Metropolitan Boro of Poplar (England)	Spearing	3	2259
“	Charbonnages de Ressaix, Belgium	Stirling	1	550
“	Societe Semet Solvay & Riette, Brussels	Ladd	2	1615
“	Society Generale Belg. d'Enterprises Elec. Brussels	B & W	6	7850
“	Companie Auxiliare d' Elect. Brussels	B & W	1	808
“	Soc. Hoiller Sarre & Moselle, Marlebach	S. A. C. M.	1	1076
“	Estab. Gillet & Fils Lyons	Joya	2	753
“	Intercommunale Belge d' Electricite, Brussels	Ladd	1	887
“	Soc. Gen. Elec. della Sicilia, Milan	B & W	1	915
1929	Milwaukee Elec. Ry. & Lt. Co	Heine	1	2364
“	Consumers Power Co	Walsh & Weidner	1	1609
“	P. Carey Co	Walsh & Weidner	1	470
“	Viscose Co	B & W	3	3000
“	Frazer Paper Co	Badenhausen	1	941
“	Louisiana Power Co	Walsh & Weidner	1	1593
“	Penn. R. R.	Walsh & Weidner	2	5246
“	Inland Steel Co	Heine	2	3580
“	Granite City Steel Co	Walsh & Weidner	1	436
“	Nekoosa Edwards Paper Co	Stirling	1	911
“	National Cash Register Co	Heine	1	735
“	Ford Motor Co	McAleenan	3	4983
“	John Morrell & Co	Stirling	1	911
“	Akron Steam Heating Co	B & W	1	877
“	Georgia Power Co	Walsh & Weidner	2	6040

Year.	Customer.	Make of Boiler.	No.	Horse power.
1929	Fisher Lumber Co	Heine	1	887
“	University of Chicago	Heine	1	1204
“	Louisville G. & E. Co	Walsh & Weidner	1	1530
“	City of Detroit	Walsh & Weidner	2	956
“	Champion Fibre Co	Heine	1	1826
“	Iowa Public Service Co	Heine	1	1120
“	Murray Corp	Heine	1	1001
“	Hudson Motor Car Co	Heine	1	.....
“	Mallinkrodt Chem. Co	Heine	1	604
“	Kansas City P. & L. Co	Ladd	1	1516
“	Milwaukee Elec. Ry. & L. Co	Heine	2	4728
“	Bethlehem Steel Co	Comb. Eng. Corp.	2	10460
“	Bethlehem Steel Co	Comb. Eng. Corp.	2	10460
“	Ford Howard Paper Co	Stirling	1	699
“	British Empire Steel Co	Stirling	2	1822
“	Ford Motor Co	Ladd	2	6408
“	Brown Co	Walsh & Weidner	1	1049
“	City of Moose Jaw	Walsh & Weidner	1	601
“	Soc. Electrique De La Sidernogie Lorraine	Stirling	1	806
“	Soc. Gle. Metallurgique Brussels	Cockerill	1	570
“	Soc. Gle. Metallurgique Brussels	Cockerill	1	533
“	Soc. Alais, Groges & Chamargue, Paris	Stirling	4	1858
“	Soc. Intercommunale Belge d' Electrique, Brussels	B & W	3	3930
“	Soviet Government	Joya	4	5600
“	Cooperative De Fluid Electrico, Spain	Garbe	3	....

136 Murray Water Wall Installation Reported by International Combustion Engineering Corporation and Sold During Receivership on New Boiler Installations.

Year.	Customer.	Make of boiler.	No.	Horse power.
1930	City of Moose Jaw	Not Reported	..	601
“	Viscose Co	Not Reported	..	1014
“	Standard Oil Co	Not Reported	..	2080
“	Spokane Central Heating Plant	Not Reported	..	1533
“	Potomac Electric Co	Not Reported	..	5480
“	New York Steam Corp	Not Reported	..	3435
“	Texas Power & Light Co	Not Reported	..	6414
“	New Westminster Asylum	Not Reported	..	187
“	Crowell Publishing Co	Not Reported	..	980
“	John Morrell & Co	Not Reported	..	923
“	Standard Oil Indiana	Not Reported	..	1040
“	Duluth Steam Heating Station	Not Reported	..	3630
“	Bethlehem Steel Co	Not Reported	..	10786
“	Pressed Steel Car Co	Not Reported	..	800
“	Brooklyn Edison Co	Not Reported	..	19560
“	West Virginia Hydro Elec. Co	Not Reported	..	6300
“	New Brunswick Elec. Pr. Comm	Not Reported	..	(?) 1209
1931	Tennessee Paper Co	Not Reported	..	980
“	Ford Motor Co	Not Reported	..	592
“	Milwaukee Elec. Ry. Co	Not Reported	..	4240
“	University of Chicago	Not Reported	..	1204
“	Boston Elec. Ry. Co	Not Reported	..	4560
“	Public Serv. Corp. of N. J.	Not Reported	..	2980
“	City of Wyandotte	Not Reported	..	1224
1933	Chrysler Motor Co	Combustion Eng.	2	*2400

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* Installed by Combustion Engineering Corp. successor to International Combustion Engineering Co.

137 Murray Water Wall Installations Reported as Sold by International Combustion Engineering Corporation on Old Boiler Installations.

Year.	Customer.
1924	St. Joseph Lead Co.
“	Ford Motor Co.
“	Ford Motor Co.
1925	Wisconsin Traction Light, Heat and Power Co.
“	Birmingham Water Works.
“	Iowa Power & Light Co.
“	Illinois Power & Light Co.
“	United Electric Light & Power Co.
“	United Electric Light & Power Co.
“	Duquesne Light Company.
“	Iowa Power & Light Co.
1926	Ford Motor Co.
“	Lake Superior Paper Co.
“	Kansas City Power & Light Co.
“	Bogalusa Paper Co.
“	Tonawanda Paper Co
“	New York Steam Corp.
“	Interborough Rapid Transit Co.
“	Firestone Tire & Rubber Co.
“	Iowa Railway & Light Co.
1927	Armour Co.
“	Anaconda Copper Mining Co.
“	Counties Gas & Electric Co.
“	Firestone Tire & Rubber Co.
“	Penn Public Service Co.
“	Chevrolet Motor Co.
“	St. Lawrence Paper Co.
“	Southern Paper Co.
“	Pittsburgh Plate Glass Co.
1928	Belle Alkali Co.
“	C. C. C. & St. L. Railroad.
“	West Penn Power Co.
“	Lane Co.
	During Receivership.
1930	United Electric Light & Power Co.
“	United Electric Light & Power Co.
“	Sioux City Gas & Electric Co.
“	Consolidated Mining & Smelting Co.

Total installations with old boilers 37

138 Murray Water Wall Furnaces Designed by Thomas E. Murray, Inc.

Customer.	Boiler.	No.	Horsepower.
United Elec. Lt. & Pr. Co	Springfield	3	4500
United Elec. Lt. & Pr. Co	Springfield	6	3768
Municipal Gas Co	B & W	1	1287
West Va. Pulp & Paper Co	Springfield	1	846

139 Some Countries in Which Murray Water Walls are Installed.

United States.
Canada.
England.
Scotland.
Holland.
Italy.
Union of S. Africa.
Belgium.
China.
France.
Malay States.
Russia.
Spain.
Argentine.
Germany.

Prominent U. S. Utilities and Railways Using Murray Water Walls.

Union Elec. Lt. & Pr. Co., St. Louis.
New York Edison Co., New York.
Brooklyn Edison Co., Brooklyn.
Duquesne Light Co., Pittsburgh.
Consolidated Gas, El. Lt. & Pr. Co., Baltimore.
Consolidated Gas Company, New York.
Southern Power Co., Charlotte.
Milwaukee Elec. Ry. & Lt. Co., Milwaukee.
Electric Bond & Share Co.
Boston Elevated Railway, Boston.
Interborough Rapid Transit Co., New York.
N. Y., N. H., & H. Railroad, Cos Cob.
Commonwealth & Southern.
New York Steam Corp., New York.
Kansas City Power & Light Co., Kansas City.
Potomac Electric Co., Washington.
Pennsylvania Railroad, Philadelphia.
Public Service Corp. of N. J., Burlington.
Commonwealth Edison Co., Chicago.
Niagara Hudson Power Co.
Associated Gas & Electric Co.

Prominent Industrial Companies in U. S. Using Murray Water Walls.

Hudson Motor Co.
St. Joseph Lead Co.
Ford Motor Co.
International Paper Co.
Mead Pulp & Paper Co.
Atlas Portland Cement Co.
U. S. Rubber Co.
Solvay Process Co.
National Enameling & Stamping Co.
Bethlehem Steel Co.
Pressed Steel Car Co.
Standard Oil Co. of Indiana.
Union Carbide & Carbon Co.
American Cyanamid Co.
Chrysler Corp.
Champion Fibre Co.
General Motors Co.
DuPont Company.
Inland Steel Co.
National Cash Register Co.
Armour Co.

140 Murray Water Wall Installations Imported as Sold by International Combustion Engineering Corporation.

New Boiler Installations.

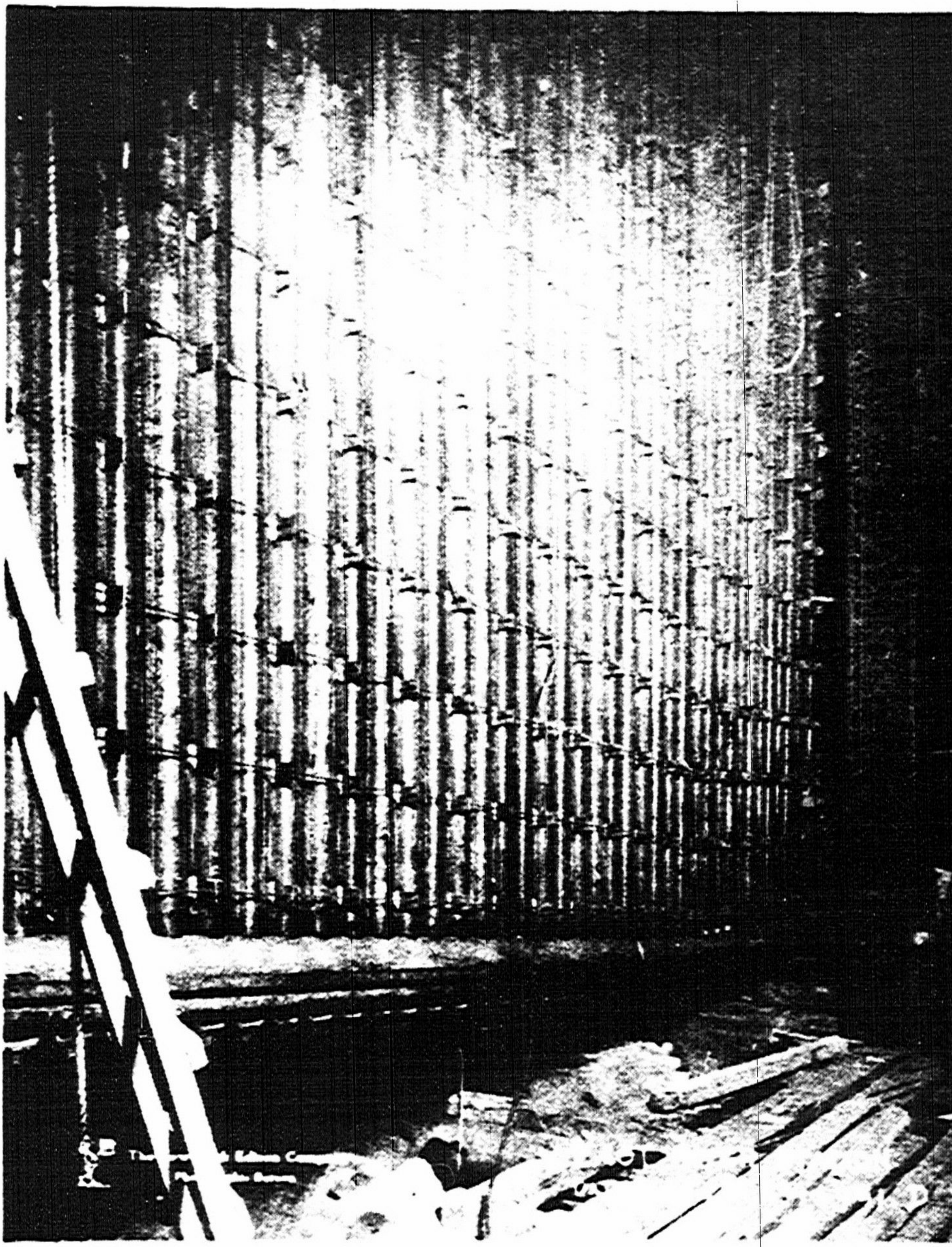
Year.	Number of installations.	Number of boilers.	Boiler horse power.
1924	6	11	18,639
1925	21	58	77,312
1926	43	114	168,783
1927	42	86	107,975
1928	51	105	121,446
1929	40	63	93,864
1930	17	Not reported	65,963
1931	7	Not reported.	15,780
1932	..	..	....
1933	1	2	2,400
Total	228	439+	672,162

Horse power of new boilers installed before receivership	588,019
Horse power of new boilers installed during receivership	84,143

IN THE SUPREME COURT OF THE
DISTRICT OF COLUMBIA

Metropolitan Engineering Co. Plaintiff,	:	In Equity No. 51,977
v.	:	
Conway P. Coe, Defendant	:	

PLAINTIFF'S EXHIBIT NO. 12-A



Boiler Insulating Rods

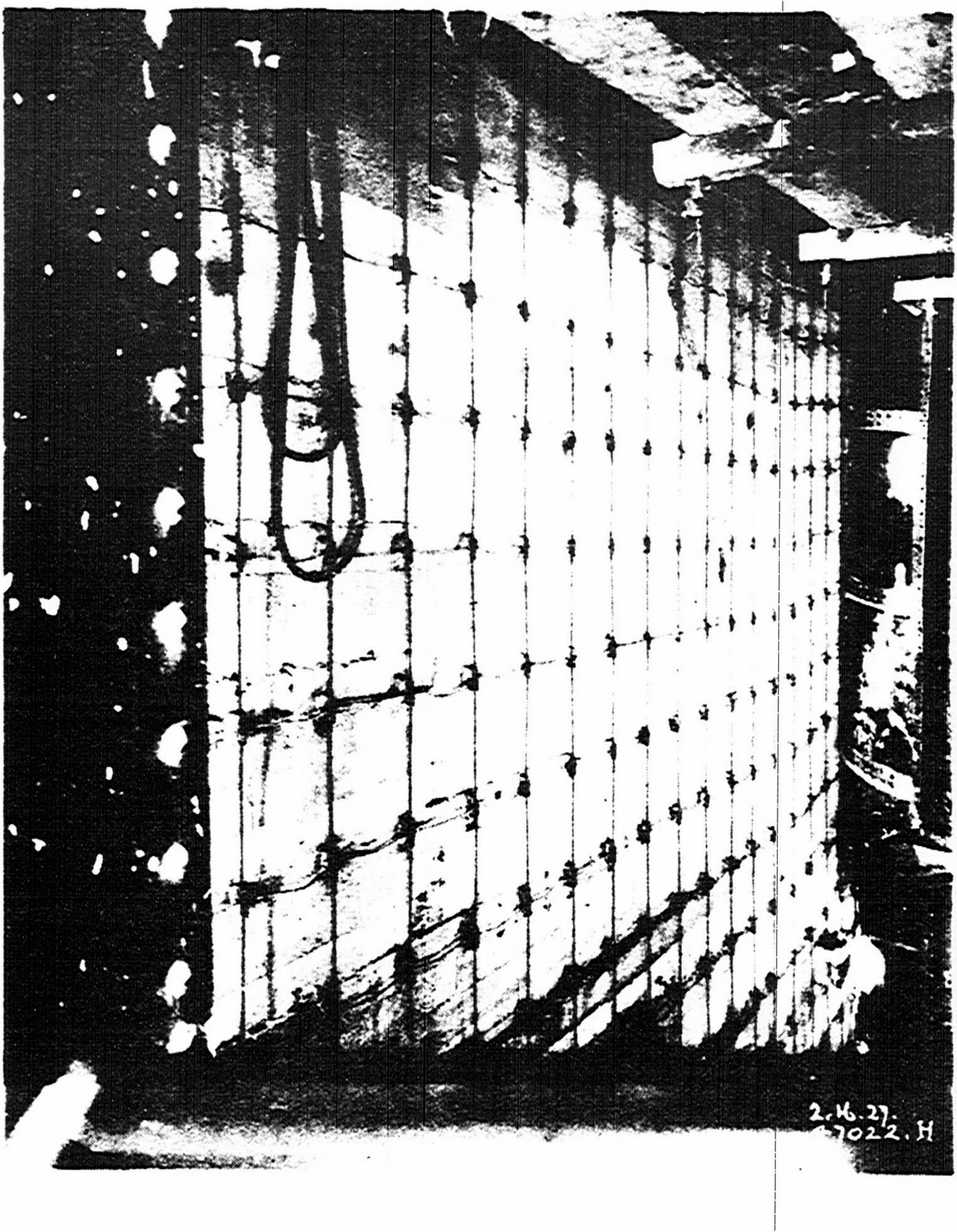
IN THE SUPREME COURT OF THE
DISTRICT OF COLUMBIA

Metropolitan Engineering Co.: In Equity
Plaintiff, : No.5,977

v. :

Conway P. Coe. :
Defendant.

PLAINTIFF'S EXHIBIT NO. 12-B

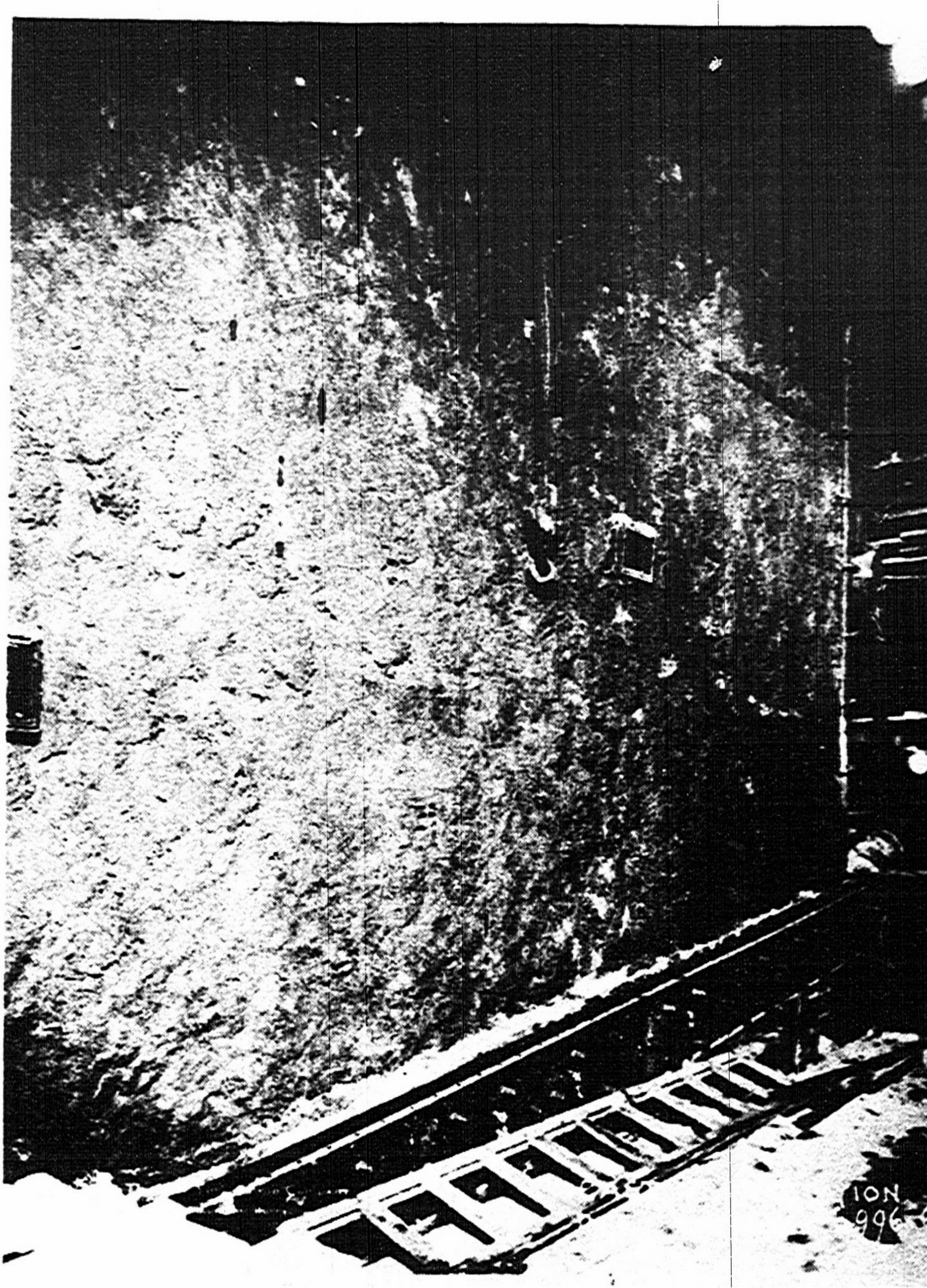


IN THE SUPREME COURT OF THE
DISTRICT OF COLUMBIA

Metropolitan Engineering Co., Plaintiff, v. Conway P. Coe, Defendant.	In Equity No. 51,977

PLAINTIFF'S EXHIBIT NO. 12-C

Thomas E. Murray, Inc.



Boiler Insulation

141 Murray Water Wall Installations Made by Thomas E. Murray, Inc.

Number of installations.	Number of boilers.	Boiler H. P.
4	11	10401

(Here follow Plaintiff's exhibits, side folios 142–144.)

145 PL. EX. NO. 13.

In the Supreme Court of the District of Columbia.

In Equity.

No. 51,977.

METROPOLITAN ENGINEERING COMPANY, Plaintiff,

v.

CONWAY P. COE, Commissioner of Patents, Defendant.

Stipulation.

It is hereby stipulated, by and between counsel for the parties hereto, that the annexed are true copies of the pending application of Thomas E. Murray for Letters Patent for Boilers, Serial No. 642,427, filed May 31, 1923, as it now stands, including the drawings and of papers Nos. 15, 18, 22½, 25 and 27, in the matter of said pending application, all being true copies from the records of the United States Patent Office.

(Signed) C. B. DES JARDINS,
Counsel for Plaintiff.

(Signed) T. A. HOSTETLER,
Counsel for Defendant.

146 *Application for United States Letters Patent.*

Petition, With Power of Attorney.

Hon. Commissioner of Patents,
Washington, D. C.

SIR:

Your Petitioner, Thomas E. Murray, a citizen of the United States, residing in the City, County and State of

New York, and whose Post Office address is No. 1250 Atlantic Avenue, Brooklyn, New York, prays that Letters Patent of the United States be granted to him for Improvements in Boilers set forth in the annexed specification.

And he hereby appoints D. Anthony Usina of No. 71 Broadway, New York City, New York, his attorney with full power of substitution and revocation, to prosecute this application, to make alterations and amendments therein, to sign his name to the drawings, to receive the Letters Patent when issued, and to transact all business in the Patent Office connected therewith.

Signed at New York City, New York, this 25th day of May, 1923.

(Signed) THOMAS E. MURRAY.

147 *Specification.*

To all whom it may concern:

Be it known that I, Thomas E. Murray, a citizen of the United States and resident of the City, County and State of New York, have invented certain new and useful Improvements in Boilers of which the following is a specification.

This invention relates to boilers and particularly to the construction of walls thereof. The invention aims to provide a unit construction whereby walls of different dimensions can be built by using various numbers of units according to the size of boiler required.

The walls are of hollow construction and are composed of a multiplicity of sections which when assembled form a unit cellular structure.

Embodiments of the invention are shown in the accompanying drawings in which Fig. 1 is a perspective view showing one type of boiler;

Fig. 2 is a diagrammatic longitudinal section through the boiler of Fig. 1;

Fig. 3 is a sectional perspective showing a portion of a boiler wall having a sheathing of heat insulating material applied thereto;

Fig. 4 is a section on line 4—4 of Fig. 3;

Fig. 5 is a horizontal section on line 5—5 of Fig. 3;

Fig. 6 is a perspective view showing a portion of the wall formed of a plurality of structural beams united along their abutting flanges;

148 Fig. 7 is a horizontal section through the wall shown in Fig. 6;

Fig. 8 is a detail showing a hollow wall member formed of a plurality of structural members united along abutting flanges;

Figs. 9 and 10 are diagrammatic views in vertical section illustrating a modified arrangement;

Fig. 11 is a horizontal section showing a further modification.

Referring first to Figs. 1 to 5, the boiler comprises side walls 10 and 12, a front wall 14 and rear wall 16, and a top wall or roof 18.

These walls are each formed of a multiplicity of hollow members which are of similar design, but are numbered differently for the purpose of identification. The side walls 10 and 12 are formed of a series of upright box-like members 20 which can conveniently be formed by butt-welding two channels along their opposed edges as indicated by the dotted line 22 in Fig. 5. Or as shown at 20^a in Fig. 8 these uprights may be made up of an H-section 24 having channel sections 26 welded along the lines 28 to form an upright having two hollow chambers.

The hollow upright members 20 are united at the top and bottom respectively with hollow headers 30 and 32. Communication between the members 20 and 30 is provided for by means of connecting nipples 34 and similarly communication between the members 20 and 32 is pro-
149 vided by means of nipples 36. As shown in Fig. 3,
the nipples may be dispensed with in which case the member 32, for example, will be formed with openings 38 and the lower edge 40 of the member 20 will be secured directly to the header 32, for example, by arc welding or acetylene welding.

The members 20 are spaced apart as shown in Fig. 5 and the openings between the members are closed by plates 42 which overlap the adjacent members and are welded or otherwise secured thereto. In Fig. 1 a number of these plates are omitted in the interest of clearness.

The rear wall 16 of the boiler is formed of a multiplicity of sections 21 similar to the members 20, and these are united at top and bottom to transverse headers 44 and 46. The hollow members 23 forming the front wall 14 are connected at the top to a header 48 and at the bottom to a header 50 by suitable nipples 52 and 54 as shown in Fig. 2.

The header 50 is raised a considerable distance above the level of the headers 32 so as to leave an opening 56 for the entrance of a known type of stoker. Instead of such stoker the boiler can be fired manually, in which case fire doors and ash pit doors, not shown, will be provided. The boiler may be provided with a suitable grate diagrammatically shown at 58, bridge wall 60 and boiler tubes 62, the latter being in communication with the hollow members 21 and 23 respectively as shown in Fig. 2. Suitable baffles 64, such as tile water tubes or brickwork will be secured in known manner to the boiler tubes so as to cause the products of combustion to follow a sinuous path through the boiler.

A flue opening 66 is formed in the roof of the boiler
150 and this connects by means of a suitable flue to a
stack not shown.

The roof 18 of the boiler is of hollow construction and can conveniently be built up of members 25 assembled as shown in Figs. 6 and 7 where it will be seen that the unit hollow structure is formed by securing a number of H-section beams to one another along the abutting edges 27 of their plates or flanges. A hollow structure made in this way can be practically any length desired by using structural beams of the required length. The width of the structure can be readily varied by using a greater or less number of H-beams secured edge to edge. At the end, the structure can be neatly finished by welding channel sections 29 to the outermost flanges or plates of the H-sections. The hollow sections forming the roof are connected by nipples 68 with the front header 48, and by nipples 70 with a header 72 which extends laterally between the top headers 30.

The ends of the members 20 can be closed by plates secured thereto and the nipples 36 above referred to can pass through suitable openings in these plates. Similarly the open ends of the chambers shown in Fig. 6 can be closed by a plate welded or otherwise secured thereto and nipples can be inserted in suitable openings in the plates. Or in some cases communication between the hollow chambers in the members will be secured by merely forming openings 31 in the walls or webs of the members as shown.

As shown in Figs. 3 to 5, the tubular structure is combined with an outer wall or layer of refractory material
such for example as the layer or sheathing 74 of heat
151 insulating material. This sheathing is held in place
by a reinforcement of woven wire mesh 76 which is

bent preferably to the shape shown in Fig. 4, and welded or otherwise secured at suitable intervals either to the plates 42 or to the members 20. This insulating material can be plastered on after the metal work has been erected. This insulating material may be a magnesia mixture or plastic compounds of asbestos and like heat insulators.

The boiler tubes 62 may be of the usual round formation and secured to the hollow members 21 and 23; these members being provided with openings opposite the tubes, which openings are closed by suitable plugs 78. The upright members 20 are provided with openings 80 which are closed by plugs 82 to give access to the interior of the members for the purpose of cleaning out the members and for insertion of tools in assembling the parts. Similar openings and plugs may be used in the various members for insertion of tools in assembling or for cleaning sediment or scale from the members as will be understood.

The feed water for the boiler may be introduced at one or more points and in Fig. 1 for this purpose I have shown a pipe 84 entering the lower header 32. Similar feed pipes may be located at the opposite side of the boiler or the feed water can be supplied from a common header to several of the hollow members 20. Introducing the feed water through the headers 32 and passing it through the walls of the furnace preheats the water and cools the walls. This enables me to build the walls of structural sections of thin cross-section, instead of making walls of masonry or brickwork as heretofore used for stationary boilers.

152 In Fig. 11, I have shown a further modification wherein the pipe sections 86^a have secured thereto members formed with plates 100 which overlap as shown. These overlapping plates are preferably not secured to each other but merely contact so as to form a joint which will permit of relative expansion and contraction between the members.

Fig. 9 shows diagrammatically a vertical section of a boiler comprising a series of front headers 110 disposed horizontally and connected by tubes 112 with similar horizontal members 114 at the rear. The headers 110 and 114 are connected to one another by means of nipples 116 to provide communication.

The tubes 112 can be arranged in different banks as shown and the header sections may be separated at intervals and connected to one another by pipes 118 and 120 in the front

and rear of the boiler. As shown in this figure, the top of the boiler comprises a series of hollow horizontal members 122, only one of which appears in the figure. These horizontal members may be formed, for example, of structural shapes as shown in Figs. 6 and 8 or they may be assembled in a manner similar to the members 20 forming the side walls as illustrated in Fig. 3. The top headers 110 and 114 are connected with the members 122 by pipes 124 and 126 as shown. The lowermost headers 110 and 114 are in communication with hollow walls 128 and 130. These walls may be of the structure shown in Fig. 3 or they may be formed of continuous members extending transversely for the full width of the boiler. The wall 128 is supported on a transverse hollow box-like member 132, which is raised from the floor level 134 so as to provide an opening
153 136 for the entrance of a mechanical stoker. The
wall 130 is supported on a transverse hollow box-like member or sill 137, and both the members 128 and 130 are connected with their supporting sills by suitable nipples as shown. The side walls of the boiler shown in Fig. 9 are built up of a multiplicity of members 20 such as shown in Fig. 3, and described in connection with Fig. 1.

Fig. 10 is a fragmentary view similar to Fig. 9 but showing headers 110^a of slightly larger cross-section than the headers shown in Fig. 9, each header being adapted to receive two rows of tubes 112^a. The other parts of this boiler are substantially the same as those shown in Fig. 9 and are indicated by like reference numerals.

While it is convenient to build boiler walls by using rolled structural sections such as channels, H-beams, I-beams and the like as herein described, I contemplate also using pressed metal sections which can be formed of boiler plate as will be understood.

The boiler walls may be supported in the usual manner on a floor or other foundation. Or walls of the kind described can be hung or suspended from the structural beams or girders in a power house or other building.

Boilers of the present type are designed to generate large quantities of steam at high temperature and pressure by the use of water walls immediately surrounding the combustion chamber and utilizing the radiant heat of the burning fuel, in addition to the inclined tubes above the combustion chamber heated by convection.

154 My improved boiler is designed to produce steam at a rate of several hundred per cent of the usual rating based on area exposed to the heating gases and requires for this result a high volume of intensely hot gas. It becomes important therefore to prevent the exposure of the usual masonry wall to the fire. Experience shows that such walls are rapidly deteriorated under modern high temperature firing. The metal fillers or extensions of my improved boiler form a shield which protects any outside sheathing, the tubes with the metal fillers or extensions constituting in effect a wall of the combustion chamber so that the plastic material on the outside may be a mere insulating sheathing supported by the wall of tubes and fillers.

The fillers or extensions have an additional function to conduct heat to the water tubes so rapidly as to utilize the intense heat of the fire. In installations of this character the distance to which the extensions may be carried beyond the tubes is limited. It must be so short that the heat is conducted to the tubes sufficiently rapidly to prevent the outer portions of the extensions from being burned away or distorted sufficiently to crack them. Such conduction of heat to the tube is affected by the area and the degree of contact of the extension member with the tube, but is chiefly dependent on the distance from the tube to the remotest part of the extension. Such distance puts a maximum limitation on the distance between the tubes in the case of high duty boilers (that is, steam generators as distinguished from mere water heaters or the like).

155 In practice, I have found that the maximum distance should not be substantially greater than the outside diameter of the tubes. The extensions beyond the tube, with such spacing, are of less width than the diameter of the tubes and can be kept within such limits as to avoid destruction by the fire. For example, in Figs. 5 and 11 it is apparent that no part of the extensions is far removed from the cooling effect of the water in the tubes; or, in other words is so far that it cannot conduct its heat to the nearest tube at the same rate that it receives heat from the fire.

Generally in boilers of the type on which the present invention is an improvement, particularly those designed to generate large quantities of steam at high temperature and pressure, the walls of the furnace support the overhead

structure and are made of or lined with refractory brickwork which is exposed directly to the intense heat of the flame and which have a comparatively short life. There are frequent shut-downs for repair or replacement of such walls. According to this invention the principal part of the wall is the tubular metal structure. Not only does this provide for a high capacity because of the rapid generation of steam by exposure of the tubes to the direct radiant heat of the burning fuel, but also the life of the wall, cooled by the rapid circulation of water, is practically unlimited. The insulating material outside of the metal wall is used only for the conserving of heat and is protected from excessive wear by the metal structure between it and the fire. It is important also that I propose to substitute my improved
water walls for the old brick-work supporting walls
156 around the entire combustion chamber.

Certain features of improvement disclosed herein are claimed in other pending applications Nos. 642,725 filed June 1, 1923 and 678,443 filed December 4, 1923.

157 Though I have described with great particularity the details of the embodiments of the invention shown, it is not to be construed that I am limited thereto as changes in arrangement and substitution of equivalents may be made by those skilled in the art without departing from the invention as defined in the appended claims.

What I Claim Is:

19. A steam generator including in combination approximately horizontal water tubes heated by convection and a furnace having a combustion chamber below said overhead tubes, a wall of said combustion chamber being composed of substantially upright tubes connected into the circulation of the generator, said tubes being spaced apart a distance not substantially greater than their diameter and metal extensions from said tubes united thereto with good heat conducting joints and practically closing the spaces between them so that only the tubes and extensions are exposed to the heat of the burning fuel and the two together constitute the wall heated only on its inner face, the outer surface of such wall being covered with a sheathing of insulating material united to and supported by said wall.

20. A steam generator including in combination approximately horizontal water tubes heated by convection and a

furnace having a combustion chamber below said overhead tubes, a wall of said combustion chamber being composed of substantially upright tubes connected into the circulation of the generator, said tubes being spaced apart a distance not substantially greater than their diameter, and metal extensions from said tubes united thereto
158 with good heat conducting joints and practically closing the spaces between them but being free to move separately, so that only the tubes and extensions are exposed to the heat of the burning fuel and the two together constitute the wall heated only on its inner face, the outer surface of such wall being covered with insulating material.

21. A steam generator including in combination approximately horizontal water tubes heated by convection and a furnace having a combustion chamber below said overhead tubes, a wall of said combustion chamber being composed of substantially upright tubes connected into the circulation of the generator, said tubes being spaced apart a distance not substantially greater than their diameter, and metal extensions from said tubes united thereto with good heat conducting joints and practically closing the spaces between them and providing an increased area exposed to the direct radiant heat of the burning fuel and conducting such heat to the tubes, each of said extensions being limited in width as a maximum to the diameter of the tubes, the tubes and extensions constituting a substantially closed wall exposed on the inner face only to the combustion gases, the outer surface of such wall being covered with a sheathing of insulating material united to and supported by said walls.

22. A steam generator including in combination approximately horizontal overhead water tubes heated by convection and a furnace having a combustion chamber below said overhead tubes, all the walls of said combustion chamber being composed of rows of upright tubes connected into the circulation of the generator and exposed to the heating gases on the inner sides only of said rows of tubes, the outer surface of such walls being covered with a sheathing of insulating material united to and supported by said walls.

159 23. A steam generator including in combination water tubes heated by convection and a furnace having a combustion chamber, a wall of said chamber being

composed of water tubes connected into the circulation of the generator, said tubes being spaced apart a distance not substantially greater than their diameter, and metal extensions attached to said tubes with good heat conducting joints and practically closing the spaces between them, so that only the tubes and extensions are exposed to the heat of the burning fuel and the two together constitute a wall heated on its inner face only, the outer surface of said wall being covered with a sheathing of insulating material attached to and supported by said wall.

24. A steam generator including in combination water tubes heated by convection and a furnace having a combustion chamber adjacent to said tubes, a wall of said combustion chamber being composed of water tubes connected into the circulation of the generator, said tubes being spaced apart a distance not substantially greater than their diameter, and metal extensions from said tubes attached thereto with good heat conducting joints and practically closing the space between them but being free to move separately, so that only the tubes and extensions are exposed to the heat of the burning fuel and the two constitute a wall heated only on its inner face, the outer face of said wall being covered with insulating material.

25. A steam generator including in combination water tubes heated by convection and a furnace having a combustion chamber adjacent to said tubes, a wall of said combustion chamber being composed of tubes connected into 160 the circulation of the generator, said tubes being spaced apart a distance not substantially greater than their diameter, and metal extensions from said tubes attached thereto with good heat conducting joints and practically closing the spaces between them, and providing an increased area exposed to the radiant heat of the burning fuel and conducting such heat to the tubes, each of said extensions being limited in width as a maximum to the diameter of the tubes, the tubes and extensions constituting a substantially closed wall exposed on the inner face only to the combustion gases, the outer surface of said wall being covered with a sheathing of insulating material attached to and supported by said walls.

26. A steam generator including in combination water tubes heated by convection and a furnace having a combus-

tion chamber adjacent to said tubes, all the walls of said combustion chamber being composed of tubes connected into the circulation of the generator and exposed to the heating gases on the inner side of said rows of tubes, the outer surface of said walls being covered with a sheathing of insulating material attached to and supported by said walls.

27. A steam generator including in combination water tubes heated by convection and a furnace having a combustion chamber, a wall of said chamber being composed of water tubes connected into the circulation of the generator, said tubes being spaced close together so as to approximately close the opening between adjacent tubes and the wall heated on its inner face only, the outer surfaces of said wall being covered with a sheathing of insulating material attached to and supported by said wall. 161

In witness whereof, I have hereunto signed my name.

(Signed) THOMAS E. MURRAY.

162 Oath.

STATE OF NEW YORK,
County of New York:

Thomas E. Murray, the above named Petitioner, being duly sworn, deposes and says that he is a citizen of the United States and a resident of the City, County and State of New York, that he verily believes himself to be the original, first and sole inventor of the Improvements in Boilers described and claimed in the foregoing specification; that he does not know and does not believe that the same was ever known or used before his invention or discovery thereof, or patented or described in any printed publication in any country before his invention or discovery thereof, or more than two years prior to this application, or in public use or on sale in the United States for more than two years prior to this application; that said invention has not been patented in any country foreign to the United States on an application filed by him or his legal representatives or assigns more than twelve months prior to this application; and that no application for patent for said invention has been filed by him or his legal representatives or assigns in any country foreign to the United States.

(Signed) THOMAS E. MURRAY.

Sworn to and subscribed before me this 25th day of May, 1923.

(Signed) JOHN C. McDERMOTT,
Notary Public.

Kings Co. Clerk's No. 158; Reg. No. 5069; New York Co. Clerk's No. 161; Reg. No. 5119; Commission expires March 30, 1925.

(Here follow drawings, side folios 163-167.)

168 [Stamp:] Mailed Jan. 14, 1929.

Paper No. 15

Div. 46, Room 235.

Department of Commerce, United States Patent Office, Washington.

Address only "The Commissioner of Patents, Washington, D. C.," and not any official by name.

All communications respecting this application should give the serial number, date of filing, and name of the applicant.

Please find below a communication from the Examiner in charge of this application.

THOMAS E. ROBERTSON,
Commissioner of Patents.

Bl/R

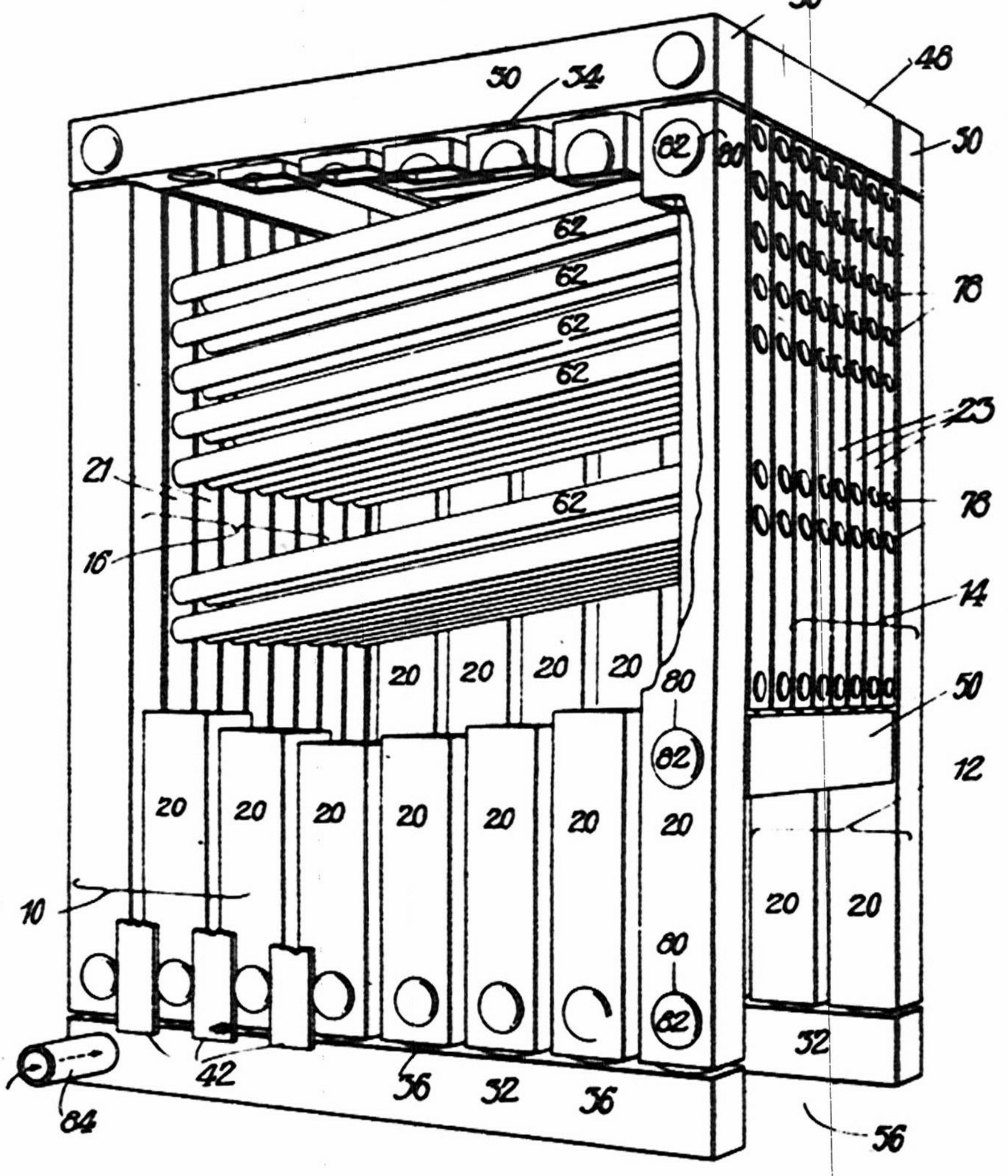
Applicant: Thomas E. Murray.
Ser. No. 642,427.
Filed May 31, 1923.
For Boilers.

D. Anthony Usina,
71 Broadway,
New York, N. Y.

Responsive to amendment filed June 6, 1928.

Claims 19, 21 and 22 are again rejected on the Griffiths patent of record. It is not seen that the general combina-

Fig. 1.



O. G. FIG.
CLASS
SUB CLASS

Inventor
Thomas E. Murray.
By his Attorney
B. Anthony

6-2
7

Fig. 2.

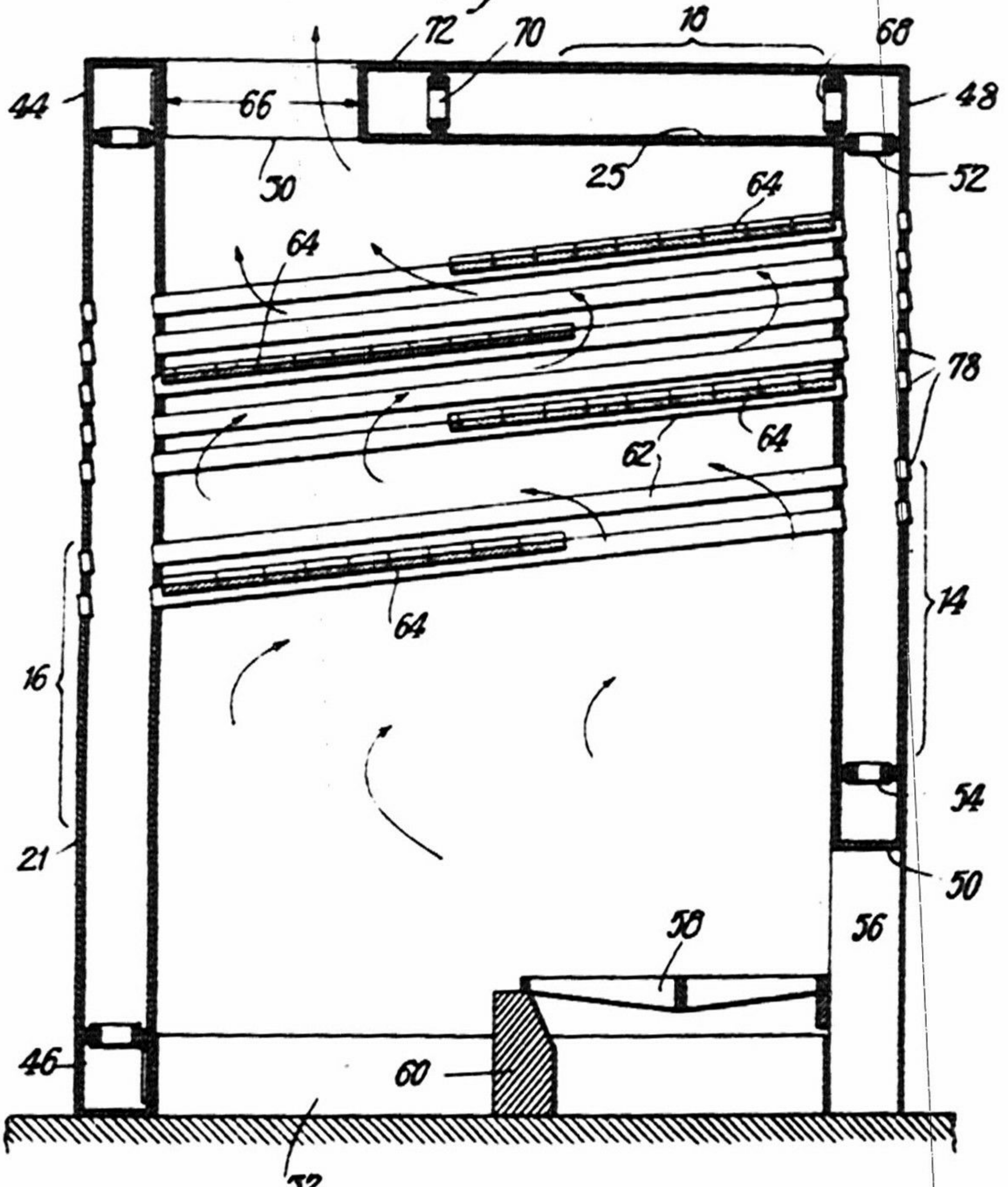
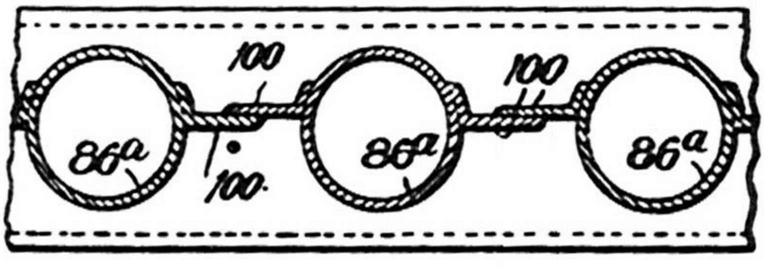


Fig. 11.



Inventor
Thomas E. Murray.
By His Attorney
D Anthony Usina

* 112

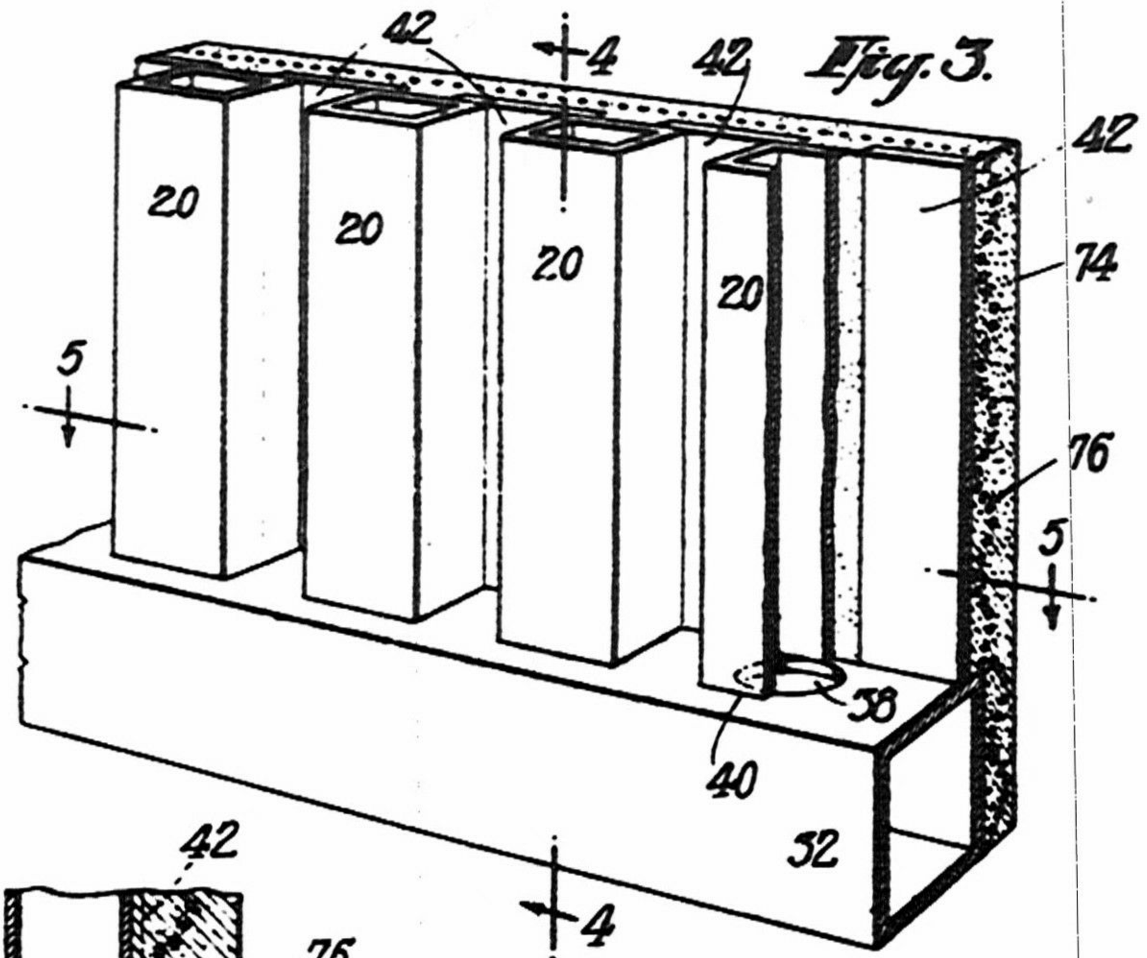


Fig. 3.

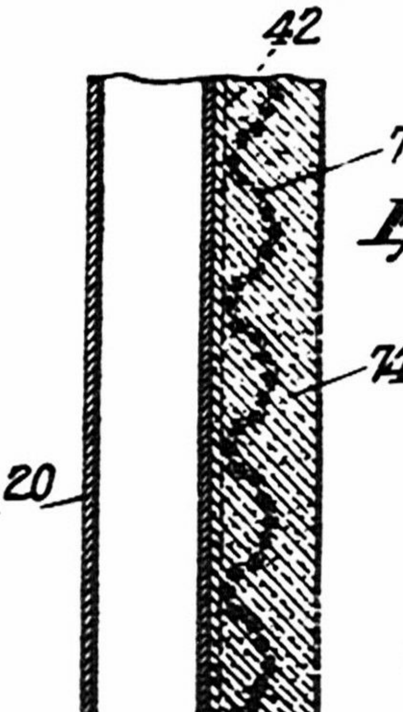
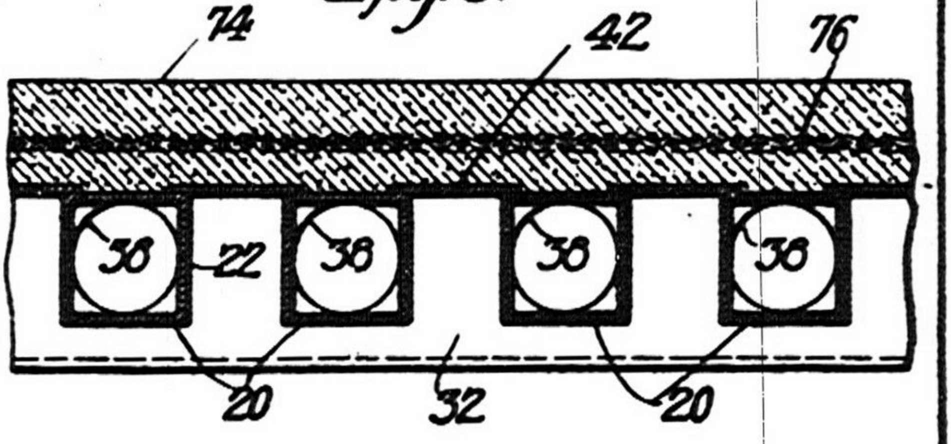


Fig. 4.

Fig. 5.



Inventor
Thomas E. Murray.
By his Attorney
B. D. Anthony Usina

6 - 6
4

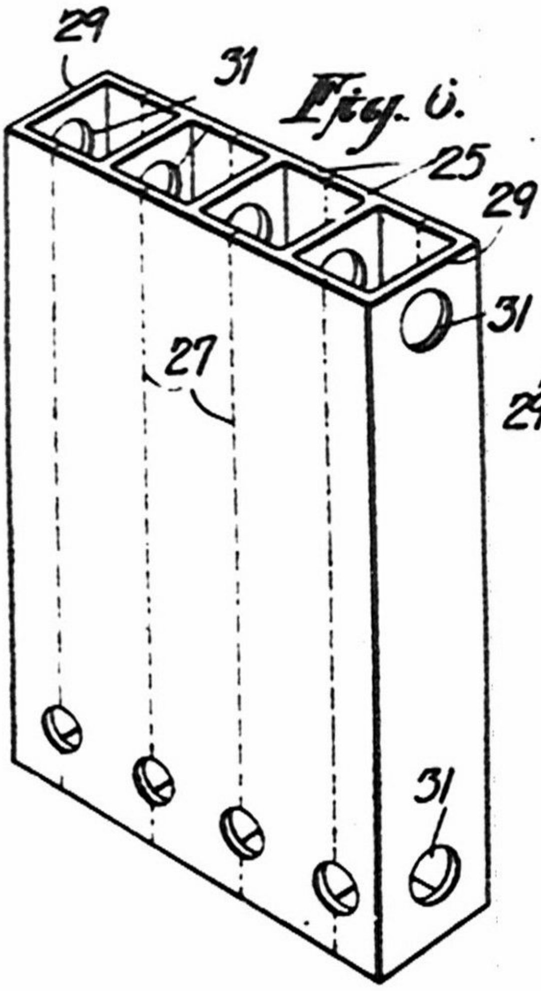


Fig. 6.

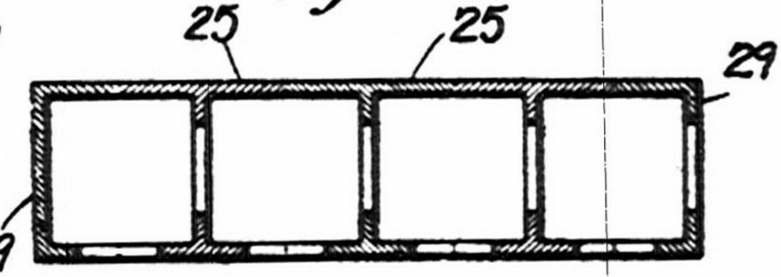
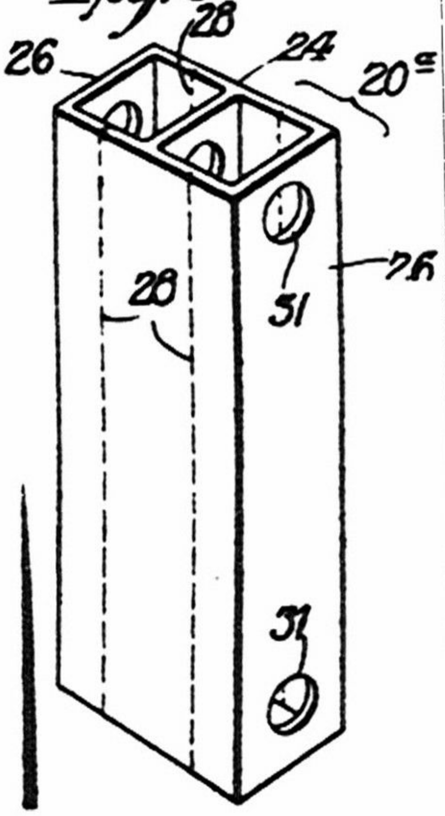


Fig. 7.

Fig. 8.


6-5-
-5

Fig. 9.

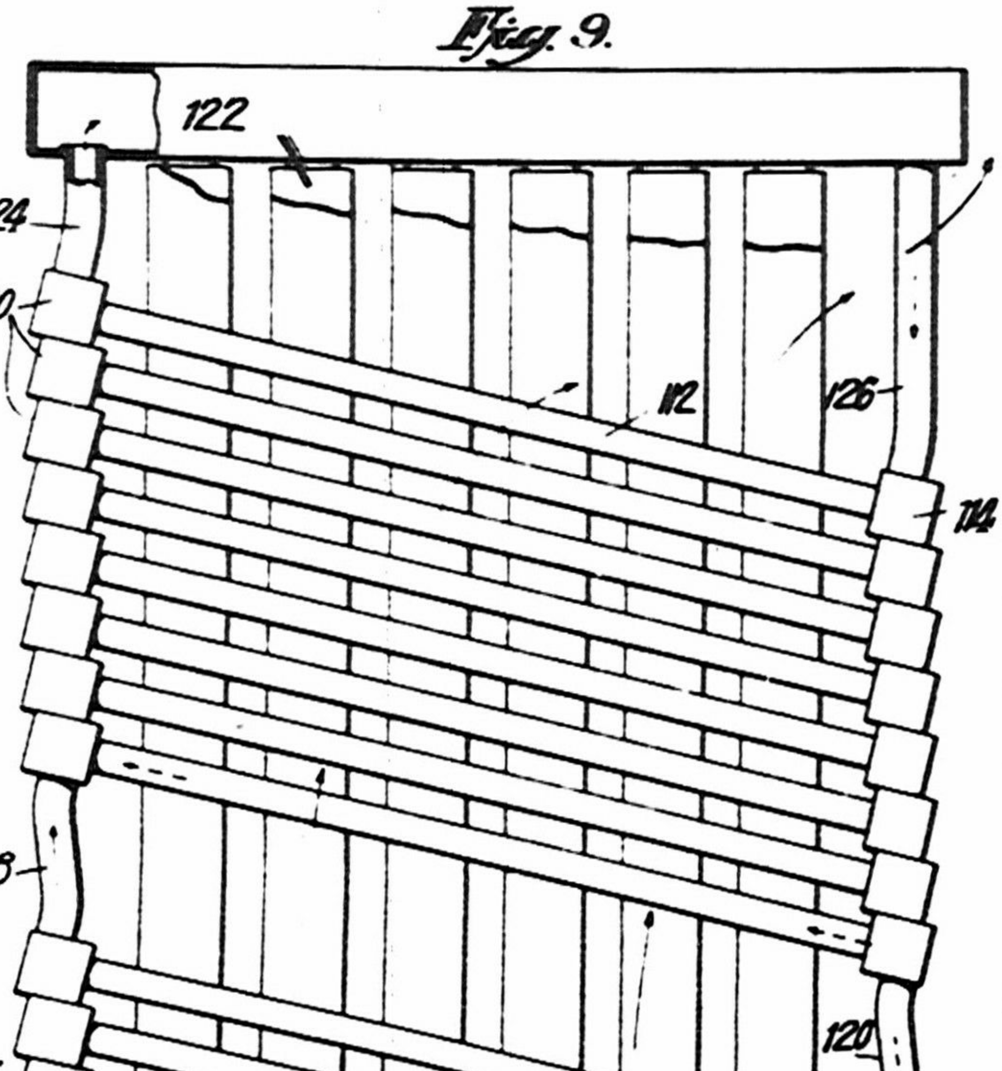
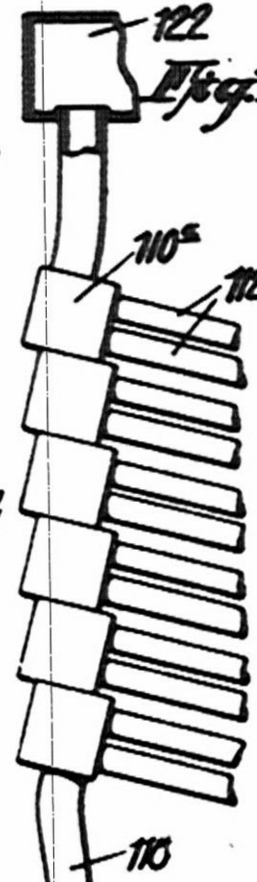


Fig. 10.



Inventor

Thomas E. Murray.

By his Attorney

D. Anthony Usina

*112

tion to which these claims are directed is changed by the relation between the water wall and the outside refractory. Moreover, the claimed relation between the water wall and the casing is shown by McClellon, 1,474,156, of record. The relationship appears to be of the same kind whether embodied in a stationery or a steam locomotive boiler. The asbestos insulation "87" of McClellon is clearly united to and supported by the tubes, since the plate "89" is merely added to protect such insulation. The contacting and supporting relationship between water wall and refractory as shown in McClellon could be adopted in Griffiths without invention. The specific wall structure set forth in claims 19 and 21 is found in McClellon.

Claim 20 stands allowed.

In view of the long pendency of the case and of the fact that no new reference is herein cited, this rejection is made final.

C. L. WOLCOTT,
Examiner.

169 [Stamp:] Mailed Jul. 25, 1929.

Paper No. 18.

Before the Board of Appeals.

In re Application of Thomas E. Murray. Serial No. 642,-427. Filed May 31, 1923. For Boilers.

Examiner's Statement.

This is an appeal from the action of the Examiner finally rejecting the following claims:

19. A steam generator including in combination approximately horizontal water tubes heated by convection and a furnace having a combustion chamber below said overhead tubes, a wall of said combustion chamber being composed of substantially upright tubes connected into the circulation of the generator, said tubes being spaced apart a distance not substantially greater than their diameter, and metal extensions from said tubes united thereto with good heat conducting joints and practically closing the spaces between them so that only the tubes and extensions are exposed to the heat of the burning fuel and the two together

constitute the wall heated only on its inner face, the outer surface of such wall being covered with a sheathing of insulating material united to and supported by said wall.

21. A steam generator including in combination approximately horizontal water tubes heated by convection and a furnace having a combustion chamber below said overhead tubes, a wall of said combustion chamber being composed of substantially upright tubes connected into the circulation of the generator, said tubes being spaced apart a distance not substantially greater than their diameter, and metal extensions from said tubes united thereto with good heat conducting joints and practically closing the spaces between them and providing an increased area exposed to the direct radiant heat of the burning fuel and conducting such heat to the tubes, each of said extensions being limited in width as a maximum to the diameter of the tubes, the tubes and extensions constituting a substantially closed wall exposed on the inner face only to the combustion gases, the outer surface of such wall being covered with a sheathing of insulating material united to and supported by said walls.

170 22. A steam generator including in combination approximately horizontal overhead water tubes heated by convection and a furnace having a combustion chamber below said overhead tubes, all the walls of said combustion chamber being composed of rows of upright tubes connected into the circulation of the generator and exposed to the heating gases on the inner sides only of said rows of tubes, the outer surface of such walls being covered with a sheathing of insulating material united to and supported by said walls.

The references relied on are:

Griffith, 743,271;
McClellan, 1,474,156.

The claimed invention relates to a water tube boiler having tubes 62 heated by convection connected to members 21 and 23 which are connected to headers 48 and 50. Members 20 form the side of the firebox and are connected to headers 30 and 32. The members 20 are spaced apart a distance not substantially greater than their diameter, and the spaces between same are closed by metal members 42 as shown in Fig. 5, or by overlapping fins 100 as shown in the preferred construction in Fig. 11. The members 42 or 100 are connected to the tubes with good heat conducting joints. The members 20, 21 and 23 form the walls of the combustion chamber. Upon the outer side of the wall, formed of the members 20, 21 and 23, there is insulating material 74 attached thereto by means of the wire mesh 76.

Griffith shows tubes 22 heated by convection and connected to headers 23 and 24. The side walls of Griffith's device are formed of tubes 33 connected to header 32 and drum 21. The headers 23 and 24 and the tube 33 are placed in such close relation that they form walls for the combustion chamber. At the outside of the tubes, but not attached thereto, is an asbestos covering. McClellan shows a locomotive fire box formed of tubes 57 connected to lower headers 58 and upper drums 53. The tubes are spaced a distance apart not greater than their diameter and the spaces between same are closed by filler strips 75 welded to the tubes. The outer faces of the walls are covered by asbestos, evidently attached to same, since the plate 89 is said to be added merely to protect such material. 171

It was held that the general combination, to which these claims are directed, was not changed by the claimed relation between water wall and the casing. That is, it seemed immaterial whether the asbestos was attached to or spaced from the outside of the tubes. Further, the type wall as shown by McClellan, with water tubes having closing strips welded thereto and having asbestos covering the outside of the tubes could be substituted for the walls of Griffith's boiler without invention.

Respectfully submitted,

C. L. WOLCOTT,
V.E.B. *Examiner, Div.* 46.

172 [Stamp:] Mailed Jul. 2, 1930.

Department of Commerce, United States Patent Office,
Washington, D. C.

Petition to Commissioner.

July 2, 1930.

Application of Thomas E. Murray. Serial No. 642,427.
Filed May 31, 1923. For Boilers.

Examiner's Statement.

The question of the admission of new claims 23 to 28 to this case has been considered. The other applications of the applicant mentioned in his petition of June 24, 1930, and the patent which has issued on one of these applications, have been reviewed.

It is believed that new claims 23 to 27 could properly be considered along with the finally rejected claims, since the subject matter of said new claims 23 to 27 is substantially the same as that of the rejected claims except that the new claims are broader in scope.

However, claim 28 would appear to be inadmissible, since it is drawn to the subject matter of claim 18 of applicant's patent 1,746,711 only broader in scope.

Respectfully,

M. TAYLOR,
Examiner.

V.E.B.

173 [Stamp:] Mailed Jul. 11, 1930.

Department of Commerce, U. S. Patent Office, Washington, D. C.

Before the Board of Appeals on Appeal.

In re Application of Thomas E. Murray. Serial No. 642,-427. Filed May 31, 1923. For Boilers.

Supplemental Examiner's Statement.

Claims 23 to 27 have been entered in the case for appeal before the Board.

23. A steam generator including in combination water tubes heated by convection and a furnace having a combustion chamber, a wall of said chamber being composed of water tubes connected into the circulation of the generator, said tubes being spaced apart a distance not substantially greater than their diameter, and metal extensions attached to said tubes with good heat conducting joints and practically closing the spaces between them, so that only the tubes and extensions are exposed to the heat of the burning fuel and the two together constitute a wall heated on its inner face only, the outer surface of said wall being covered with a sheathing of insulating material attached to and supported by said wall.

24. A steam generator including in combination water tubes heated by convection and a furnace having a com-

bustion chamber adjacent to said tubes, a wall of said combustion chamber being composed of water tubes connected into the circulation of the generator, said tubes being spaced apart a distance not substantially greater than their diameter, and metal extensions from said tubes attached thereto with good heat conducting joints and practically closing the space between them but being free to move separately, so that only the tubes and extensions are exposed to the heat of the burning fuel and the two constitute a wall heated only on its inner face, the outer face of said wall being covered with insulating material.

25. A steam generator including in combination water tubes heated by convection and a furnace having a combustion chamber adjacent to said tubes, a wall of said combustion chamber being composed of tubes connected into the circulation of the generator, said tubes being spaced apart a distance not substantially greater than their diameter, and metal extensions from said tubes attached thereto with good heat conducting joints and practically closing the spaces between them, and providing an increased area exposed to the radiant heat of the burning
174 fuel and conducting such heat to the tubes, each of said extensions being limited in width as a maximum to the diameter of the tubes, the tubes and extensions constituting a substantially closed wall exposed on the inner face only to the combustion gases, the outer surface of said wall being covered with a sheathing of insulating material attached to and supported by said walls.

26. A steam generator including in combination water tubes heated by convection and a furnace having a combustion chamber adjacent to said tubes, all the walls of said combustion chamber being composed of tubes connected into the circulation of the generator and exposed to the heating gases on the inner side of said rows of tubes, the outer surface of said walls being covered with a sheathing of insulating material attached to and supported by said walls.

27. A steam generator including in combination water tubes heated by convection and a furnace having a combustion chamber, a wall of said chamber being composed of water tubes connected into the circulation of the generator, said tubes being spaced close together so as to approximately close the opening between adjacent tubes and the wall heated on its inner face only, the outer surfaces of

said wall being covered with a sheathing of insulating material attached to and supported by said wall.

Claims 23 and 25 to 27 are for substantially the same subject matter as that covered by the claims under rejection (said subject matter being set forth at length on page 2 of the original Examiner's Statement of July 25, 1929). However, certain minor limitations contained in the rejected claims have been omitted from the new claims. Since the more specific claims, now on appeal, were held unpatentable over the references cited in the said statement, these new and broader claims would also appear unpatentable over said references.

Claims 23, 25 and 26 are based respectively on rejected claims 19, 21 and 22 with the following limitations contained in the said rejected claims omitted or changed; line 2 of each claim "approximately horizontal" omitted; line 4 "below said over head tubes" changed to *adjacent*
175 *to said tubes* or entirely omitted; line 5 "substan-
tially upright tubes" omitted in claims 23 and 25; line 5 of claim 26, "rows of upright" omitted; line 8 of claim 23, "from said tubes united thereto" has been changed to *attached to said;* last line of claim 23 "united to" has been changed to *attached to;* claim 25, line 9, "united thereto" has been changed to *attached thereto*, and next to last line "united to" has been changed to *attached to;* claim 26, line 5, "rows of upright tubes" has been changed to *tubes;* next to last line "united to" has been changed to *attached to.*

Claim 27 is based on claim 25 with the metal extensions left out.

Claims 23, 25 and 26 being substantially the same as the rejected claims upon which they are based are met by the references upon which said rejected claims 10, 21 and 22 stand rejected.

Claim 24 is modelled on the allowed claim 20 and would also appear allowable, since it carries the limitation in line 11 "being free to move separately" which was deemed to differentiate over the references of record in the allowance of claim 20.

Claim 27, in omitting the metal extension, would merely call for the omission of McClellon's filler strips "89" with a consequent loss of their function. The claim would also be met by Griffith, if the insulating material were applied to the outside of his tubes, as taught by McClellon, instead of being spaced from the tubes as now shown in Griffith.

Respectfully submitted,

M. TAYLOR,
Examiner, Div. 46.

V.E.B.

176 [Stamp] U. S. Patent Office, Board of Appeals.
Mailed Aug. 5, 1930.

Appeal No. 2722. Paper No. 27. Decision.
Hearing: July 30, 1930.
REH.

In the United States Patent Office.

Appeal No. 2722.

Before the Board of Appeals.

Ex parte Thomas E. Murray.

Application for Patent filed May 31, 1923. Serial No. 642,427. Boilers.

Messrs. Usina & Rauber for applicant.

This is an appeal from the action of the primary examiner in finally rejecting claims 19 and 21 to 27, inclusive.

Claim 21 is representative and is as follows:

21. A steam generator including in combination approximately horizontal water tubes heated by convection and a furnace having a combustion chamber below said overhead tubes, a wall of said combustion chamber being composed of substantially upright tubes connected into the circulation of the generator, said tubes being spaced apart a distance not substantially greater than their diameter, and metal extensions from said tubes united thereto with good heat conducting joints and practically closing the spaces be-
tween them and providing an increased area exposed
177 to the direct radiant heat of the burning fuel and
conducting such heat to the tubes, each of said exten-
sions being limited in width as a maximum to the diameter of the tubes, the tubes and extensions constituting a sub-

stantially closed wall exposed on the inner face only to the combustion gases, the outer surface of such wall being covered with a sheathing of insulating material united to and supported by said walls.

The references relied upon are:

Griffiths, 743,271, Nov. 3, 1903;
McClellon, 1,474,156, Nov. 13, 1923.

This application relates to water tube boilers and is generally of the type disclosed in the patent to Griffiths. The distinction in the appealed claims over this patent relates to the construction of the side walls of the boiler. In Griffiths the tubes of the side walls are not spaced apart and the outer insulating material is not carried by the tubular wall. The patent to McClellon discloses side walls having the tubes spaced apart with connecting fins and a covering of insulating material. It is probably true that in McClellon the insulating material is held in place by an outer covering rather than being attached directly to the tubular wall. It is also true that McClellon relates to a locomotive boiler rather than to a stationary boiler of the type disclosed by appellant and Griffiths.

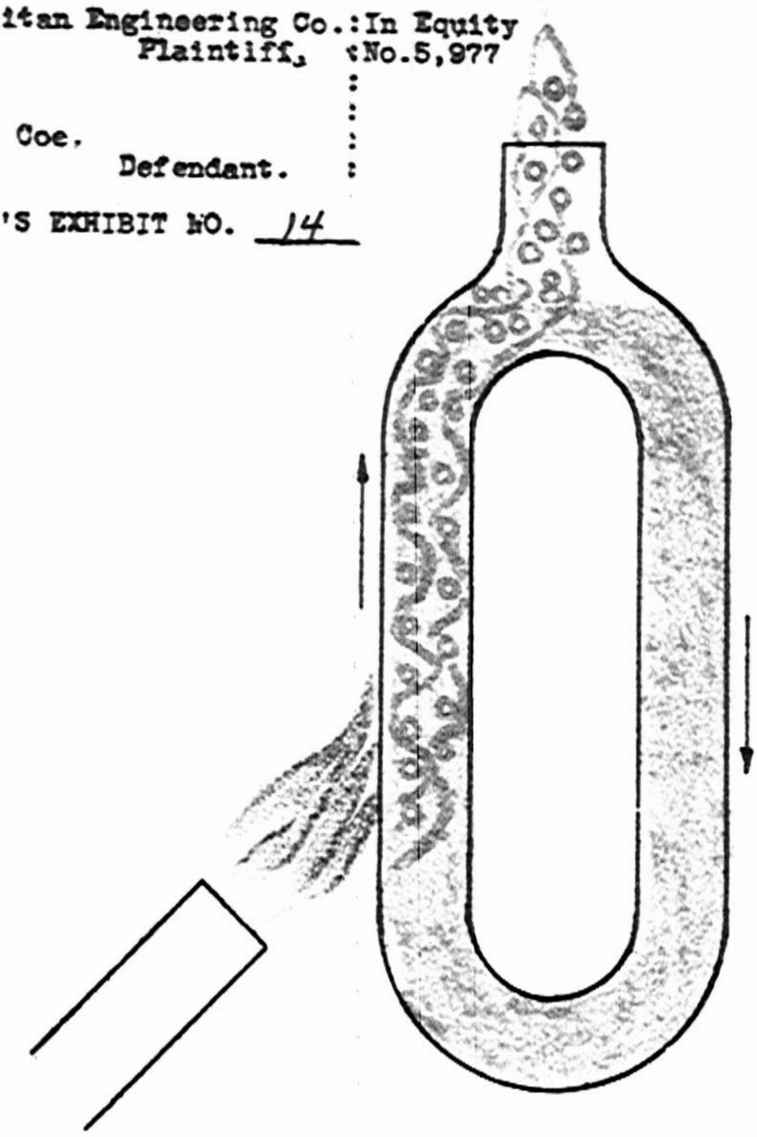
Appellant's main contention appears to be that locomotive boilers and stationary boilers relate to different 178 arts. We have given this matter careful consideration in view of the argument in the brief but it is our opinion that the structure of the tubular side walls with their insulated coverings have substantially the same functions in the two types of boilers and therefore we regard McClellon as pertinent art. We may take cognizance of the fact that it has been old for years to plaster asbestos and similar insulating material directly upon furnace walls and we are satisfied, therefore, that there would be no patentable distinction in supporting the insulation in this way on the wall of McClellon instead of holding it in position by an outer covering.

We also desire to call attention to the patent to Junkers, 1,125,113, Jan. 19, 1915, of record, where, as perhaps best shown in Fig. 5, it is old to form the walls of combustion chambers with pipes spaced apart and fins or webs connected with the pipes. We do not consider that it would involve invention to construct the side walls of Griffiths in

IN THE SUPREME COURT OF THE
DISTRICT OF COLUMBIA

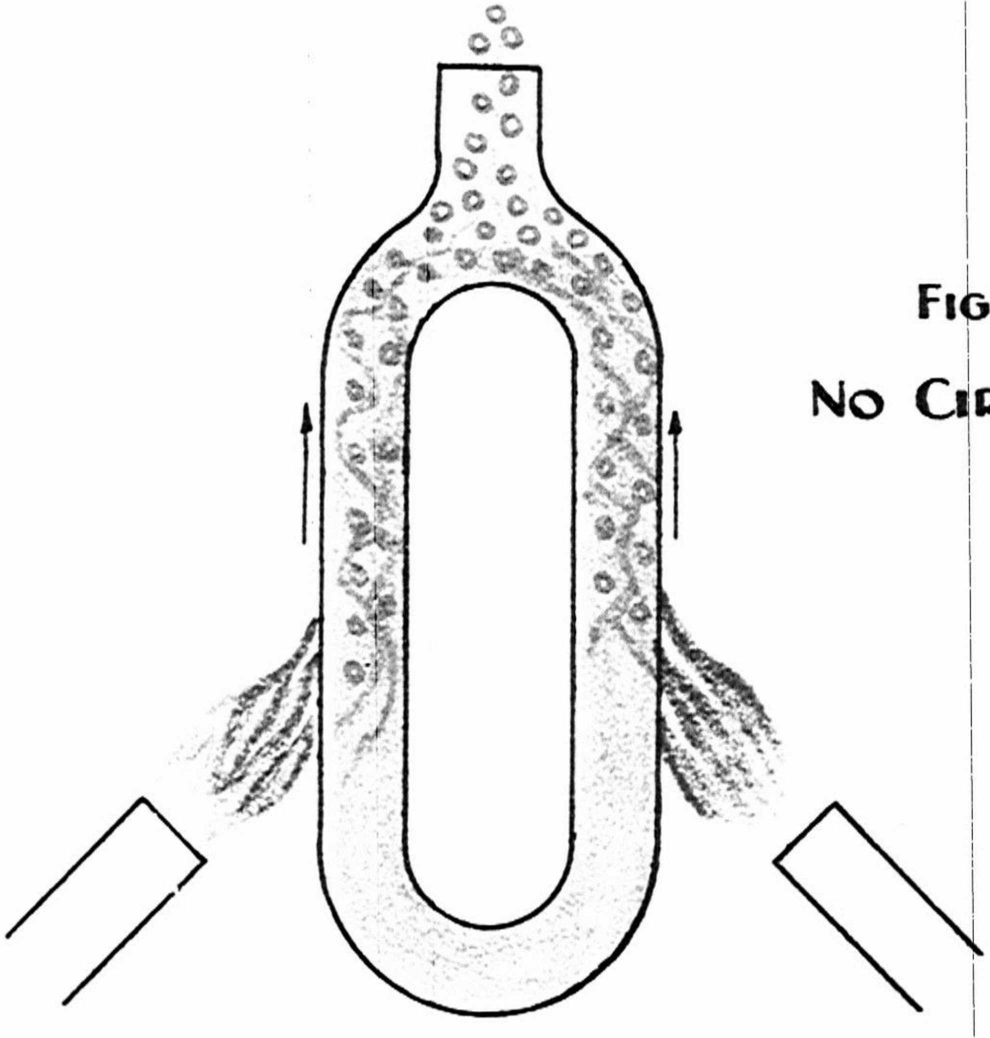
Metropolitan Engineering Co.: In Equity
Plaintiff, : No.5,977
v. :
Conway P. Coe, :
Defendant. :

PLAINTIFF'S EXHIBIT NO. 14



Fig· I

Circulation



Fig· II

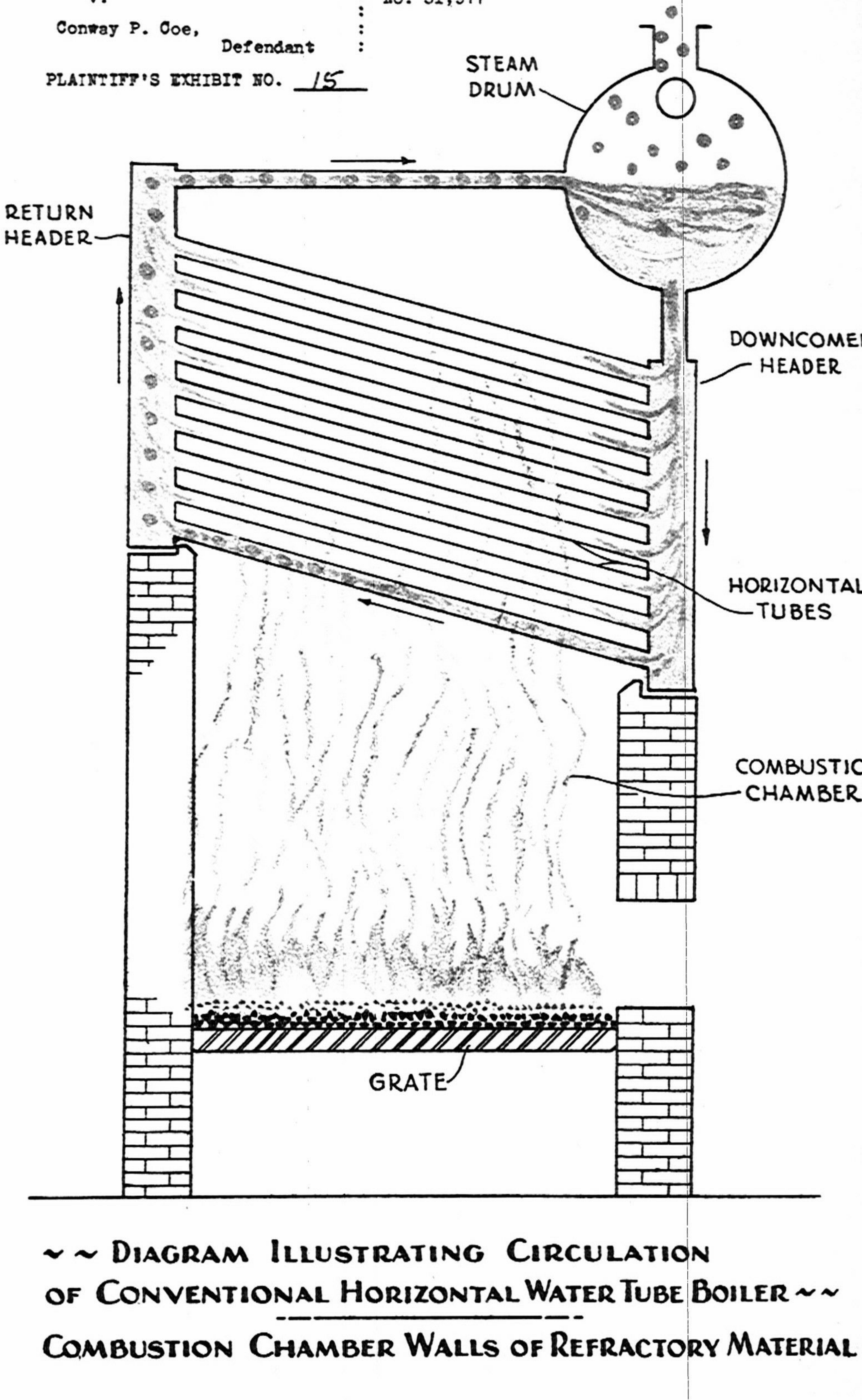
No Circulation

Diagrams Illustrating Principle of Boiler Circulation

IN THE SUPREME COURT OF THE
DISTRICT OF COLUMBIA

Metropolitan Engineering Co. :
Plaintiff, : In Equity
v. : No. 51,977
Conway P. Coe, :
Defendant :

PLAINTIFF'S EXHIBIT NO. 15



~ ~ Diagram Illustrating Circulation
of Conventional Horizontal Water Tube Boiler ~ ~

Combustion Chamber Walls of Refractory Material

IN THE SUPREME COURT OF THE
DISTRICT OF COLUMBIA

Metropolitan Engineering Co., :
Plaintiff, :
v. : In Equity
: No. 51,977
Conway P. Coe, :
Defendant. :

PLAINTIFF'S EXHIBIT NO. 16

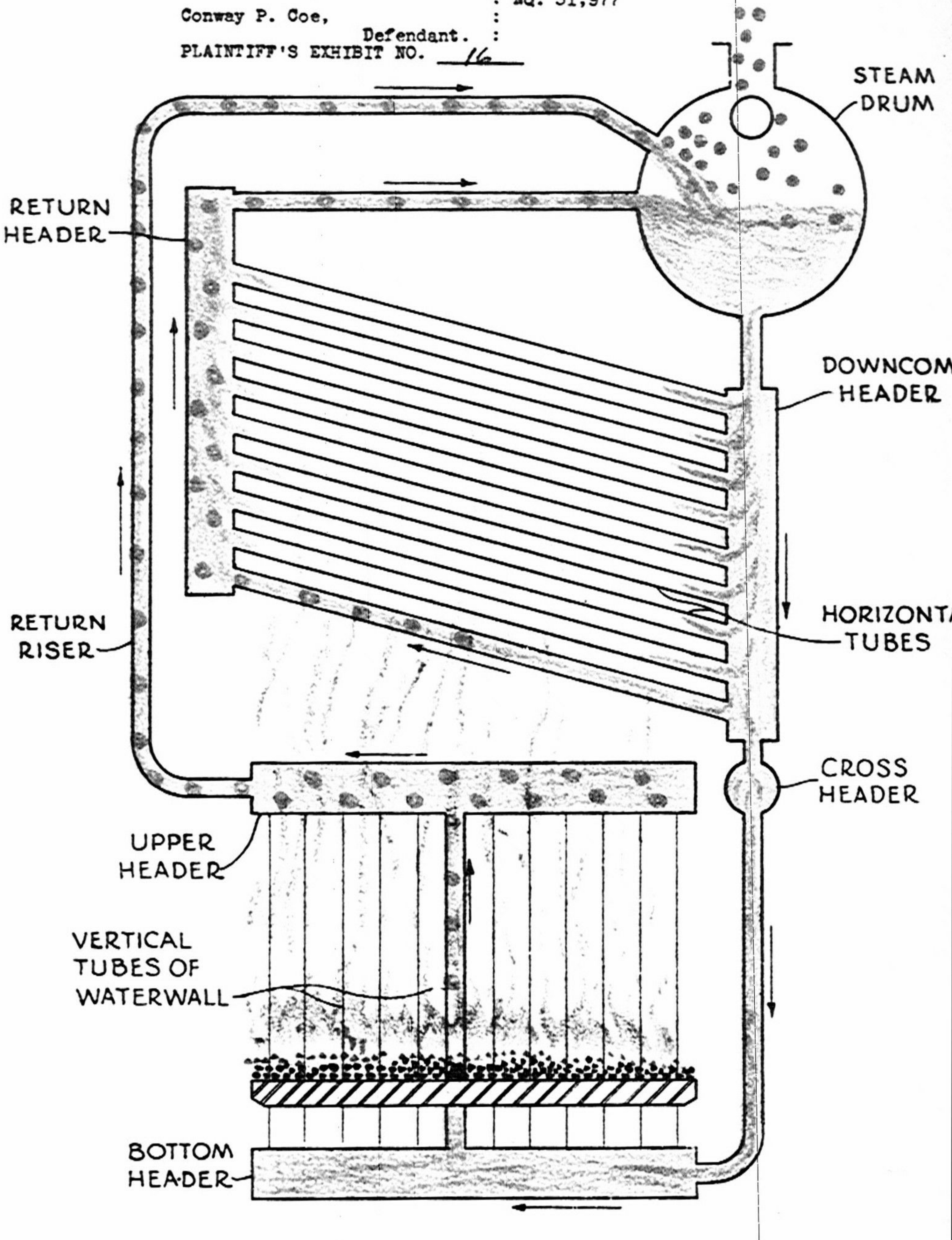


Diagram Illustrating Murray Waterwall for Combustion Chamber with Vertical Tubes Connected in the Circulation of the Boiler

(No Model.) 2 Sheets—Sheet 1.

J. A. BREEN.

HEATER.

No. 590,962. Patented Oct. 5, 1897.

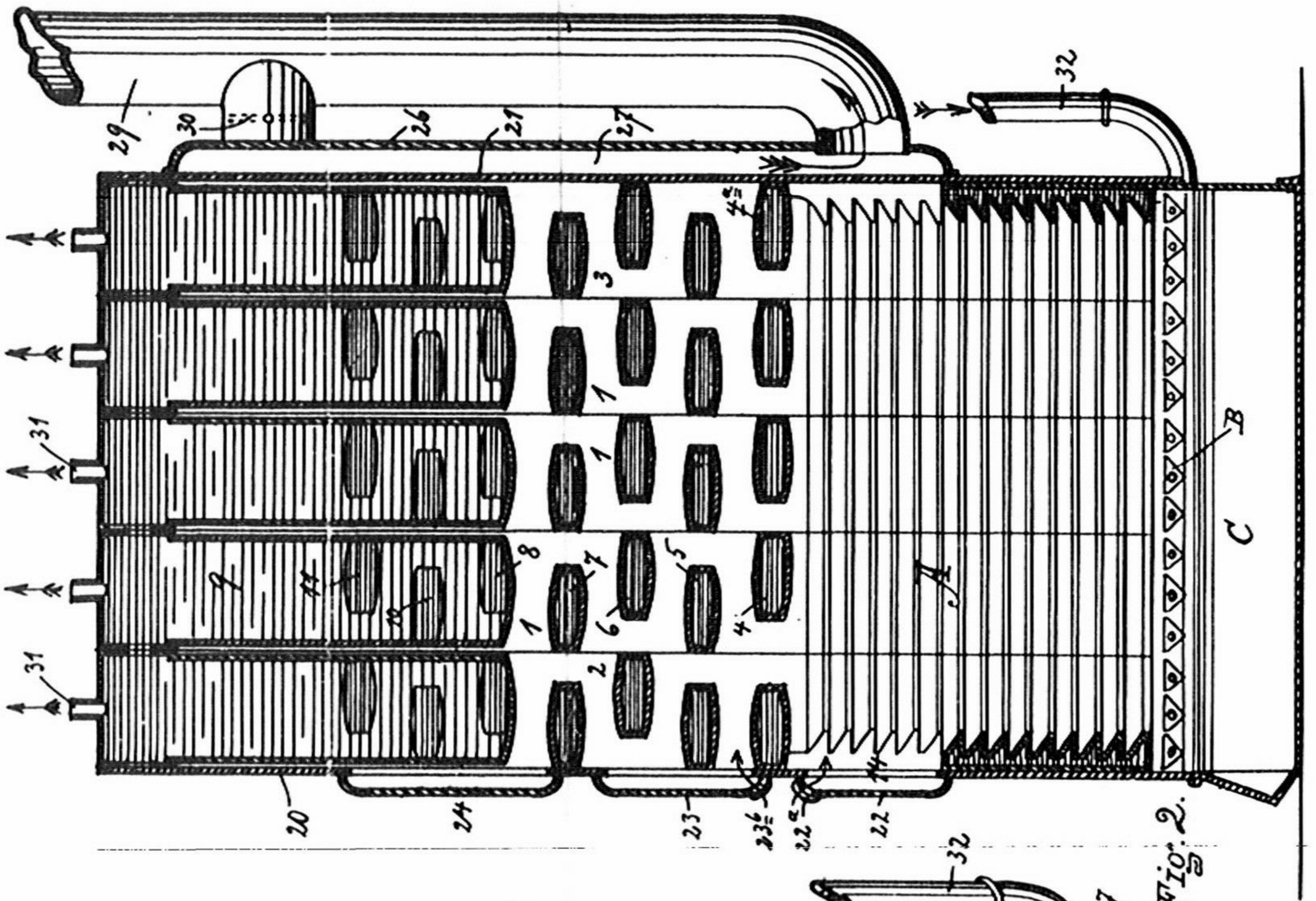


Fig. 2.

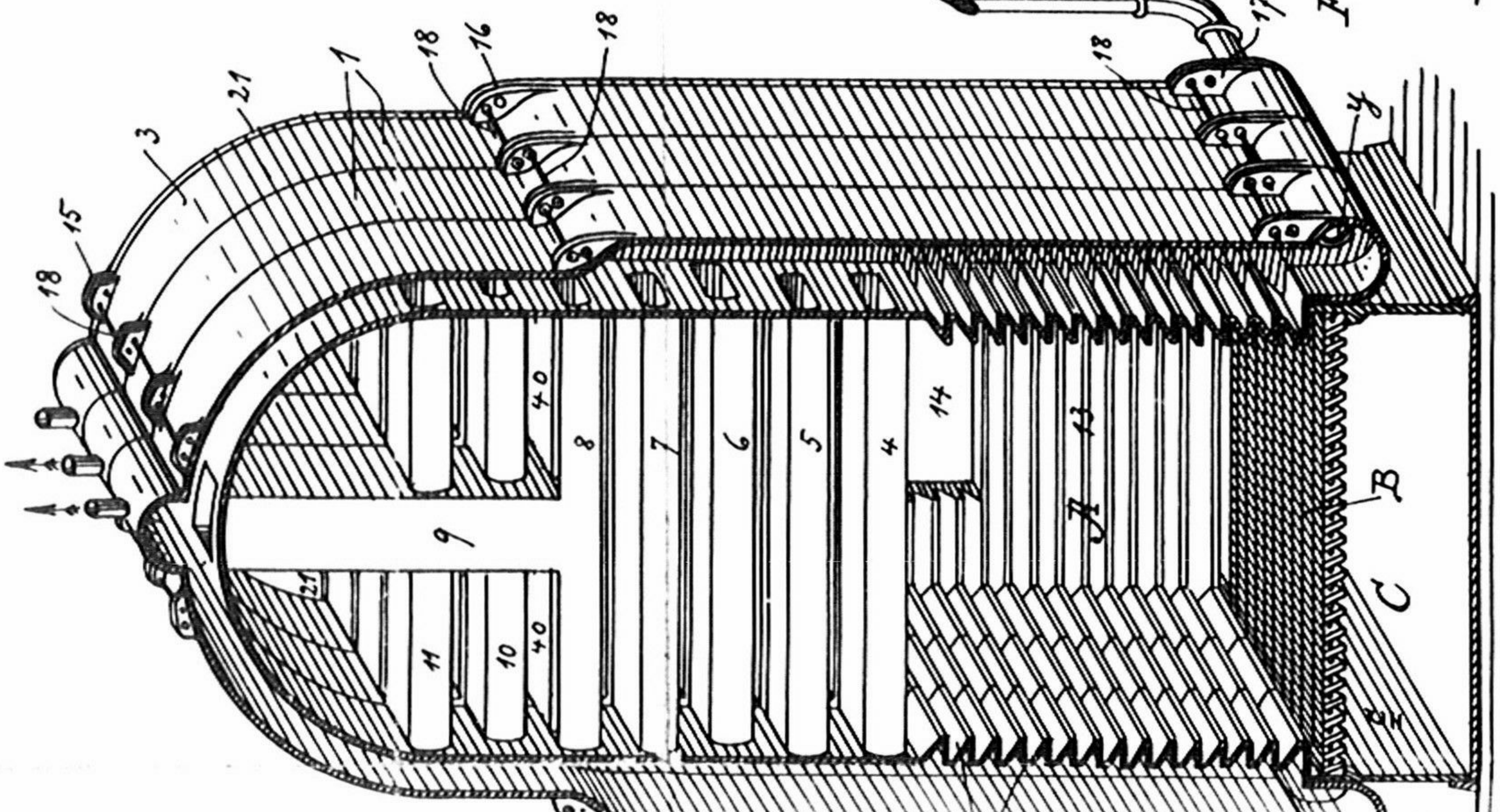


Fig. 1.

WITNESSES.
Rich. A. George
W. H. Colegrove

INVENTOR
JOHN A. BREEN
By Risley, Robinson & Love
ATTORNEY'S.

(No Model.)

2 Sheets—Sheet 2.

J. A. BREEN.

HEATER.

No. 590,962.

Patented Oct. 5, 1897.

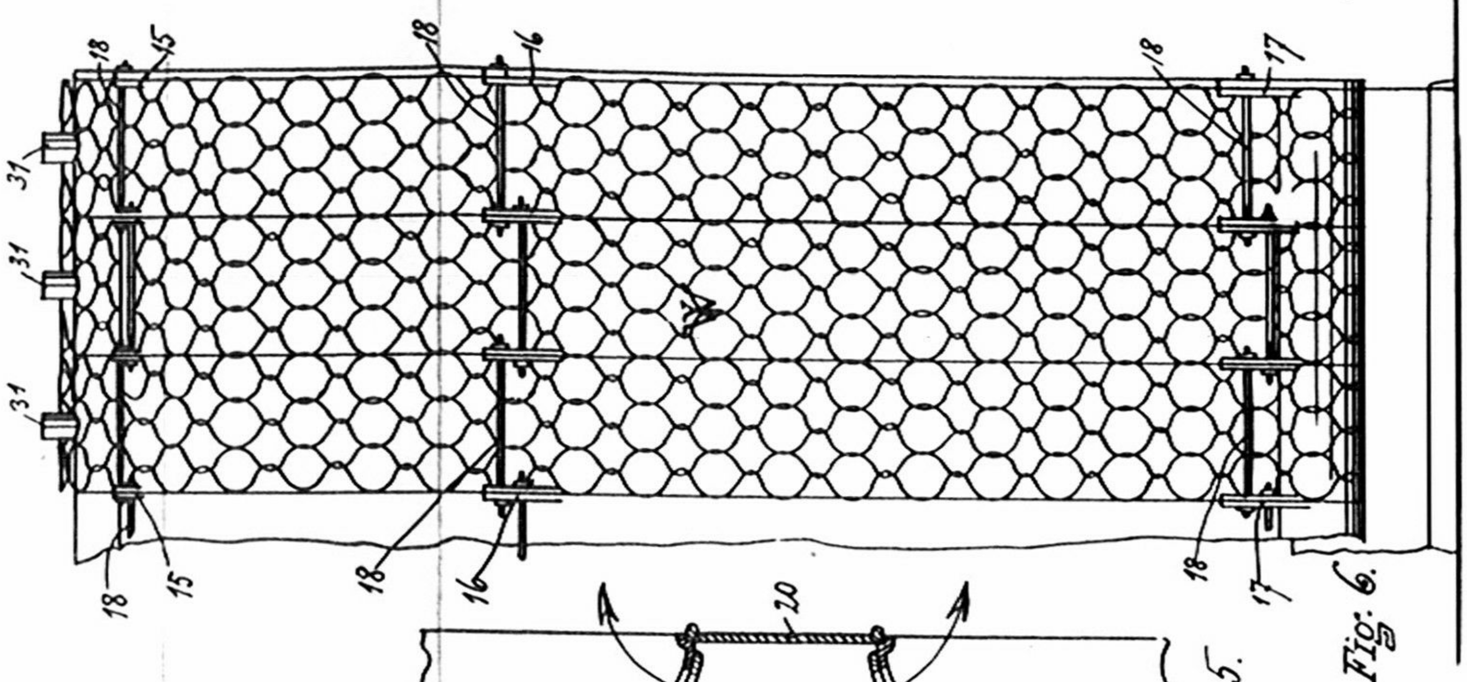


Fig. 6.

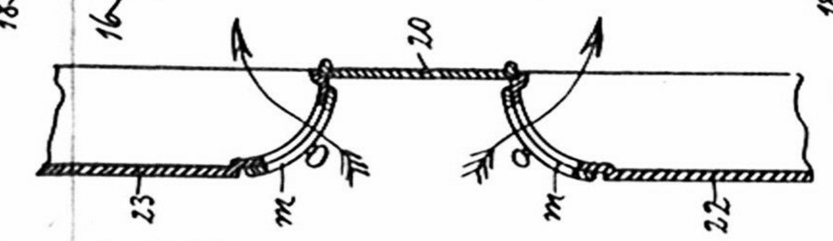


Fig. 5.

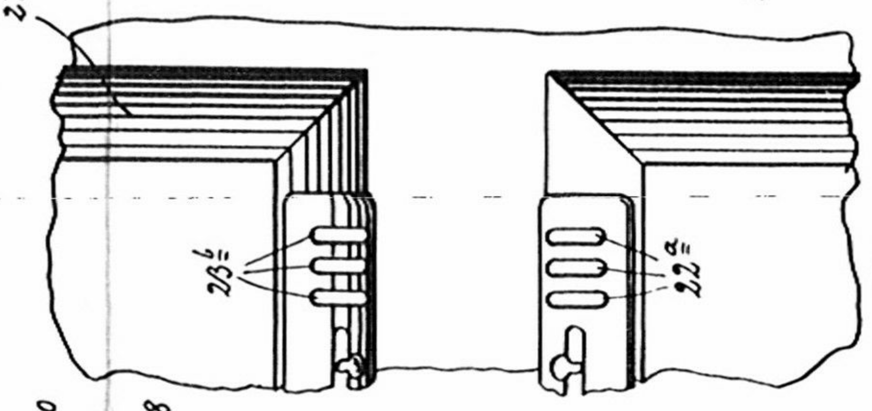


Fig. 4.

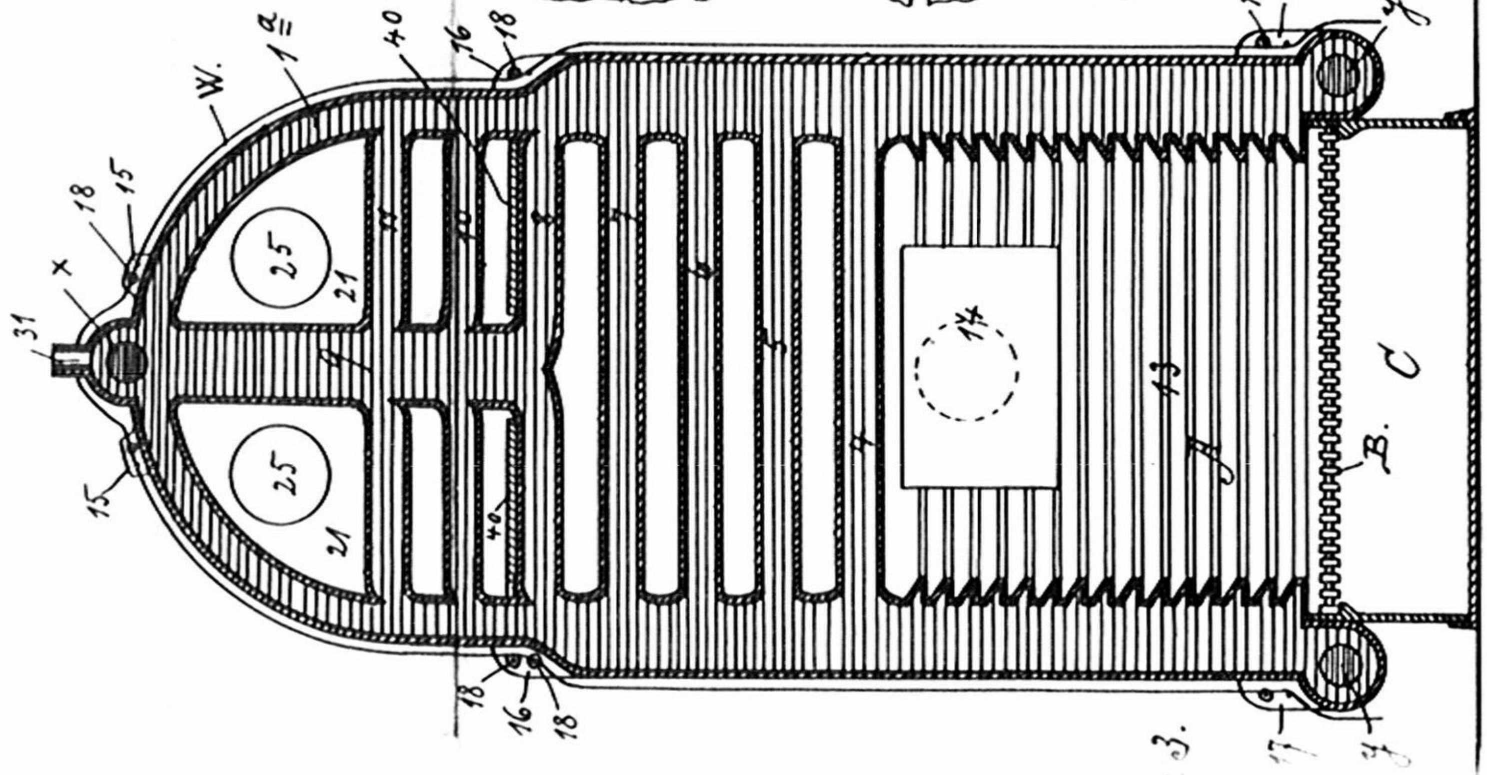


Fig. 3.

WITNESSES
Rich A. George
L. N. Colegrove

INVENTOR
JOHN A. BREEN
By Risley, Robinson & Love
ATTORNEY'S.

UNITED STATES PATENT OFFICE.

JOHN A. BREEN, OF UTICA, NEW YORK.

HEATER.

SPECIFICATION forming part of Letters Patent No. 590,962, dated October 5, 1897.

Application filed December 29, 1896. Serial No. 617,327. (No model.)

To all whom it may concern:

Be it known that I, JOHN A. BREEN, of Utica, in the county of Oneida and State of New York, have invented certain new and useful Improvements in Heaters; and I do hereby declare that the following is a full, clear, and exact description of the invention, which will enable others skilled in the art to which it appertains to make and use the same, reference being had to the accompanying drawings, and to the letters and figures of reference marked thereon, which form part of this specification.

In the drawings, Figure 1 shows a perspective view of the rear portion of a heater constructed according to my plan, the forward sections of the heater being removed. Fig. 2 shows a vertical central longitudinal section of the heater. Fig. 3 shows a vertical section of one of the sections of the heater, the rear section appearing behind the one shown. Fig. 4 shows details of draft-openings in doors employed in the construction, showing a front view of the same. Fig. 5 shows a sectional view of the same construction. Fig. 6 shows details of the connections between the several sections of the heater and the manner in which the covering is secured.

Referring to the reference letters and figures in a more particular description of the device, 1 1 1, &c., indicate the regular or intermediate sections of which the heater is composed, and 2 3 the front and rear sections. The intermediate sections are all similar in construction, as well as the front and rear sections, and the front and rear sections are somewhat similar to the regular sections, as will be noted by reference to the drawings. The regular and intermediate sections all have an inverted-**U**-shaped hollow-form body, having cross-tubes 4, 5, 6, 7, and 8 and a central upright tube 9, extending from the cross-tube 8 to the upper end of the section. Between the central tube 9 and the body portion of the section are provided also the short cross-tubes 10 and 11.

The tubes 4, 5, 6, 7, 8, 10, and 11 are alternately disposed on opposite sides of the section, as shown clearly in Fig. 2, whereby the heated gases and products of combustion are deflected and caused to travel in an irregular course, so as to encounter the largest amount of exposed surface to be heated. The upper portion 1^a of the hollow section-frame is reduced as compared with the lower portion 1^b, so that there is a greater volume of water held by the section in its lower portion than in its upper portion. The lower portion of the section straddles the fire-box A, and the lower ends of each side of the section-frames are provided with hollow tooth-like projections 12 12, &c., which have an inclined upper surface and a substantially horizontal lower surface, as shown, and when these several sections are placed together these tooth-like projections form ribs extending the full length of the sides of the fire-box. At the bottom of the fire-box is provided a grate B, and under the grate is the ash-pit C, formed by ash-pit walls *c*.

The end sections 2 and 3 are similar to the regular sections, except at the lower portion below the lowest cross-tube 4^a the space is filled up with the wall 13, which is provided with the two tooth-like ribs on its inner face and with a door-opening 14. The sections are coupled together by slip-nipples or other suitable connections at their upper ends at *x* and at their lower ends at *y y* to make provision for circulation of the water contained in the sections between the several sections. The sections are also provided with a series of corresponding lugs 15 at the top of the section 16, adjacent to the middle of the section 17, near the bottom of the section, and the sections are secured together, as well as the front and rear plates, hereinafter described, by bolts 18.

It will be noted that each section is provided with a pair of lugs at each of the points indicated, one upon either side of the section, and the bolts 18 are of a length somewhat greater than the width of one section, so as to pass through the lug of one section and span the width of an intermediate section through the lug of the next section. By this arrangement the use of the long bolt is obviated and the objectionable expansion which results from the use of long bolts in heater constructions is eliminated. The lugs or projections 15, 16, and 17 are provided with two sets of openings, as will be noted upon examination of the drawings, so that these bolts can be readily placed and removed independently of each other.

The end sections 2 and 3 being similar and each being provided with a door-opening, the heater can be readily changed about, so as to be fired from either end, as may be desired. In the construction as shown the front end of the heater is closed by a front plate 20 and the rear end of the heater is closed by a back plate 21. The plate 20 is provided with an opening into the fire-box through the opening 14 in the end section, closed by a door 22. It is also provided with clean-out openings closed by doors 23 and 24. The rear plate 21 is provided with openings 25 25 to afford smoke-passages, and these openings are covered from the outside by a jacket 26, which extends downwardly on the outside of the plate 21 and furnishes a reverse flue 27. At the upper end the jacket 26 is provided with an opening connected by a short pipe 28 with the smoke-flue 29, and in this short section of pipe is provided a damper 30. The smoke-tube 29 is extended down below the cross-pipe 28 and connects with the lower end of the reverse flue, as shown in the drawings.

It will be noted that the plate 21 closes the opening 14 in the back end of the furnace and in the section 3 as the construction is arranged in Fig. 2. It is evident that by slightly modifying the form and length of the jacket 26 and the lower end of the smoke-flue an opening and a door might be provided through this plate, so that the heater could be fired from both ends in case a heater with a large number of sections was employed. Each section of the heater is provided at its upper end at the highest point with an opening 31, to which the conducting-pipes can be attached or which may be connected with a drum to which the connecting-pipes are attached. The return-pipes 32 are attached to the foot of the rear section, as shown in Figs. 1 and 2, but in case of the use of a large number of sections in the same heater return-pipes might be attached to all four of the lower corners of the heater.

For the purpose of supplying fresh air to combine with the products of combustion above the fire there is provided in the lower side of the door 23, as shown at 23^b, and in the upper side of the door 22, as shown at 22^a, a series of openings with suitable slides or other means for controlling these openings. The slide is indicated by *m* on each of the doors.

When these heaters are set up, they are to be covered with some non-conducting material or substance in order to prevent radiation, and for this purpose I employ a plaster in which asbestos forms a large part of the material. For securing this covering on the heater I provide a wire-netting *w*, which is passed over the heater and is fitted over the lugs or projections 15, 16, and 17, as shown in Figs. 3 and 6, by having the lugs passed through the meshes of the netting before the bolts 18 are put in place. When these bolts 18 are put in place, the netting is thereby firmly secured on the heater, and when the plastering is applied it surrounds the netting, so that the netting is embedded therein, and thereby the covering is formed and secured on the heater. More or less lugs may be employed between the netting *w* and the heater, so as to hold the netting out of contact with the surface of the heater and allow considerable portions of the plaster to take a position between the netting and the surface of the heater.

The use and operation of heaters of this description being well understood, specific description of operation may be omitted. It, however, might be noted that in the fire-box the fuel is held out of contact with the body of the sections of the heater which absorbs the heat, and being so held out of contact by the tooth-like ribs or projections the fuel which lies adjacent to the walls of the heater is not cooled to such an extent that it will fail to properly consume with the fuel held in the center portion of the fire-box. The inclined upper surface of the tooth-like projections on the interior of the fire-box causes the accumulation of ashes or dust to slide off, so that the capacity of these surfaces for absorbing heat is not impaired, and exerts no detrimental influence upon the combustion. The arrangement of the cross-tubes of the sections on alternate sides of the section is such as to deflect the products of combustion as they rise from the fire in such manner as to bring them in contact with as much heat-absorbing surface as possible, whereby the best results are attained. In order to prevent the products of combustion passing directly to the smoke-exit openings 25 25, is employed a pair of plates 40 40, which are of less length than that of the heater as a whole, which are placed through the openings close by the door 24 on top of the cross-tubes 8 and at either side of the feet of the upright tubes 9. These plates are placed in the rear end of the heater, so as to cause the products of combustion to pass to the front and not directly toward the smoke-exit openings 25. These plates 40 need not be close-fitting. If they direct the major part of the products of combustion, they perform their offices sufficiently.

What I claim as new, and desire to secure by Letters Patent, is—

1. The combination with a sectional heater of hollow tooth-like rib projections 12, the upper surface of which is inclined and the lower surface substantially horizontal, extending across the several sections and lining the fire-box, substantially as set forth.

2. The combination in a heater of hollow sections, the bodies of which are of inverted-U shape having horizontal transverse tubular connections between the arms of the body portion of less transverse thickness on a horizontal line than that of the body of the sec-

tion and alternately disposed at opposite sides of the section, as shown and described.

3. The combination with a sectional heater having external lugs or projections, of a netting cover adapted to secure composition material, the netting being held by being engaged with lugs or projections and retained thereon by bolts which pass through the lugs or projections and secure the sections of the heater together, substantially as set forth.

4. A hollow heater-section of an inverted-U-shape form having a series of horizontal transverse connecting-tubes 4, 5, 6 and 7 between the arms immediately over the fire-box and other transverse horizontal tubes 8, 10 and 11 with a central vertical tube 9 of larger capacity than the other tubes, substantially as set forth.

In witness whereof I have affixed my signature in presence of two witnesses.

JOHN A. BREEN.

Witnesses:
J. C. BREEN,
RICH. A. GEORGE.

No. 743,271. PATENTED NOV. 3, 1903.

L. L. GRIFFITHS.

STEAM BOILER.

APPLICATION FILED MAR. 8, 1902.

NO MODEL. 4 SHEETS—SHEET 1.

Fig. 2.

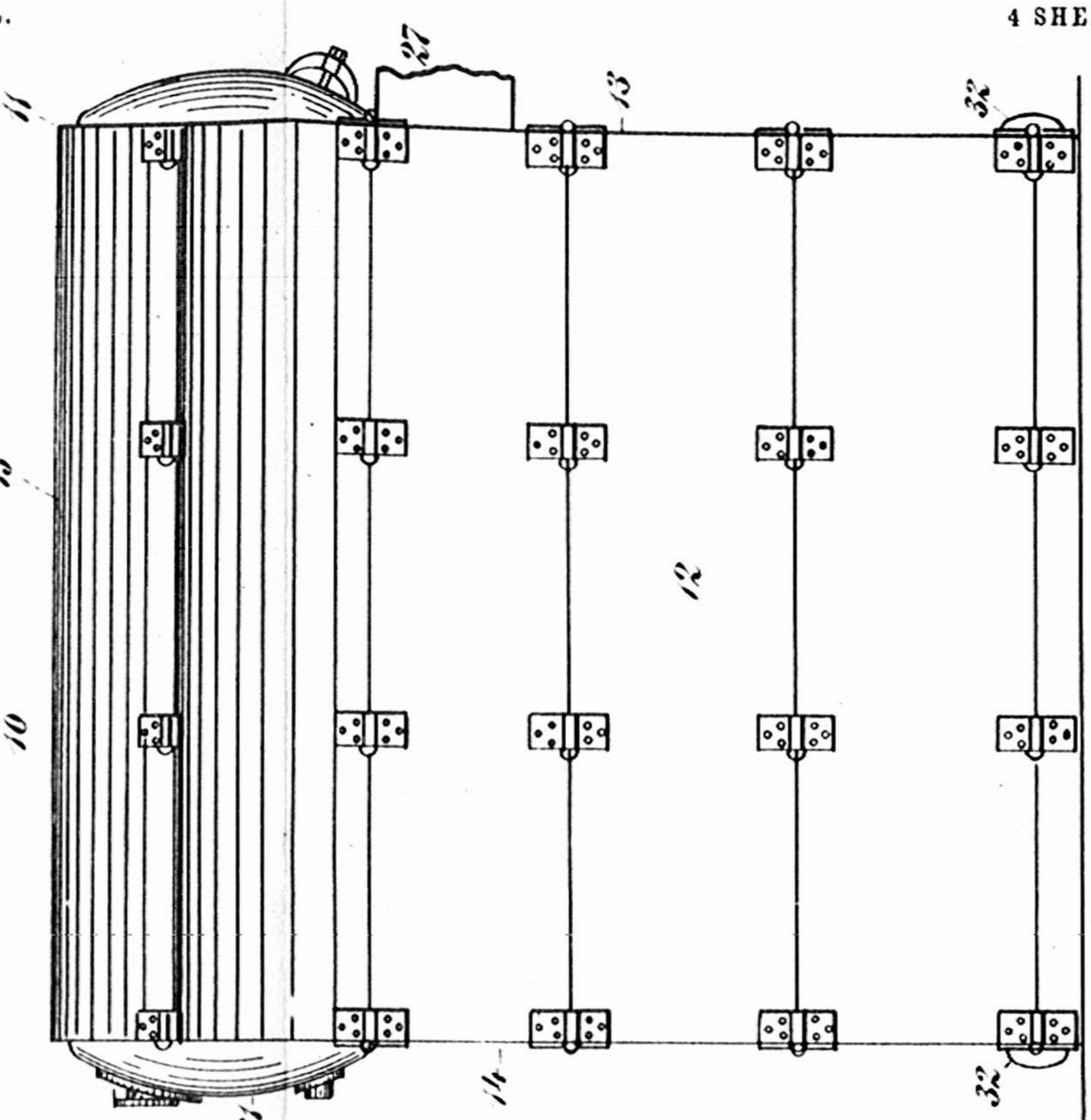
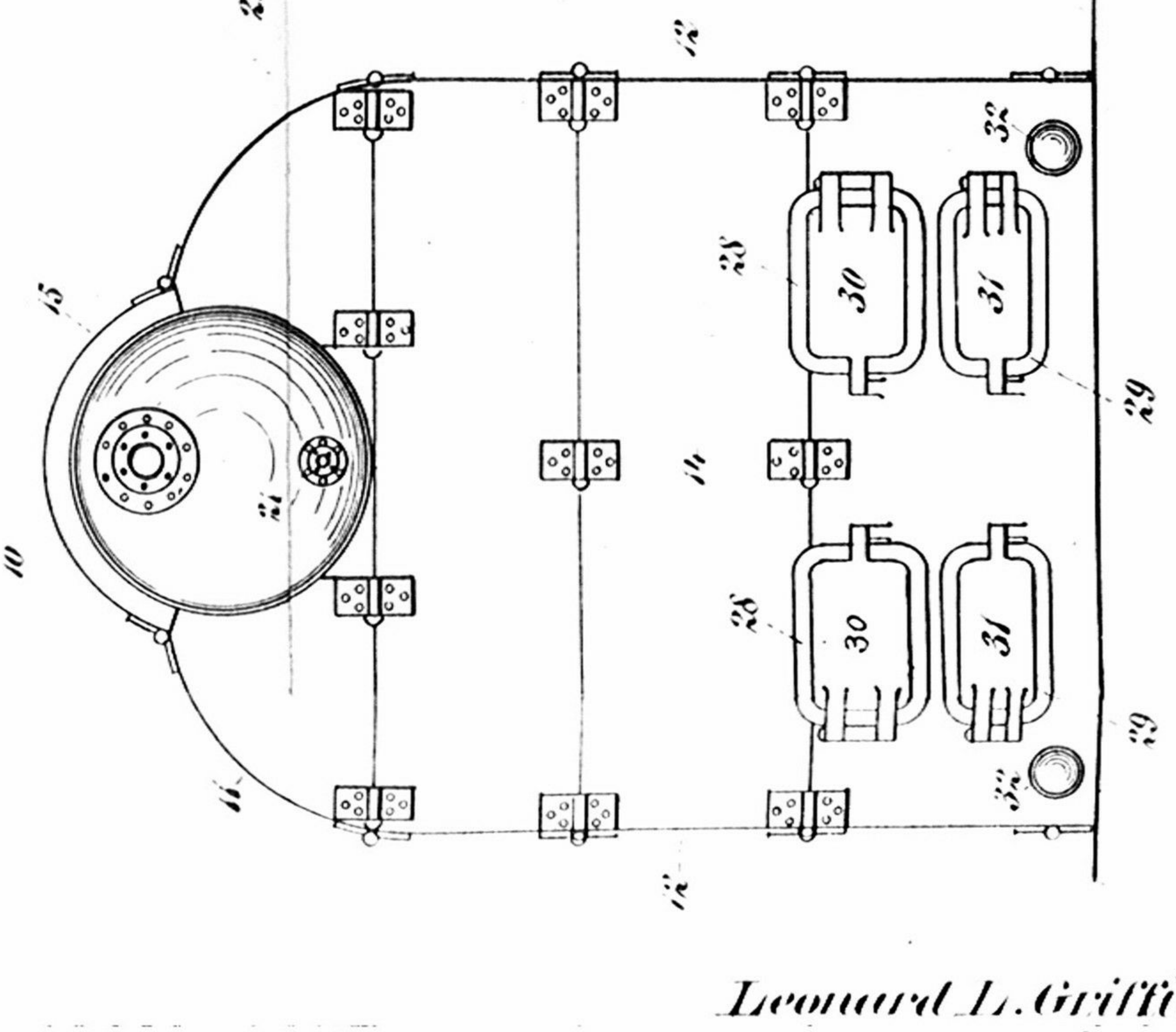


Fig. 1.



Witnesses
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Gustave Dietrich

Leonard L. Griffiths
Inventor
by C. Augustus Dieterich
his Attorney.

No. 743,271. PATENTED NOV. 3, 1903.

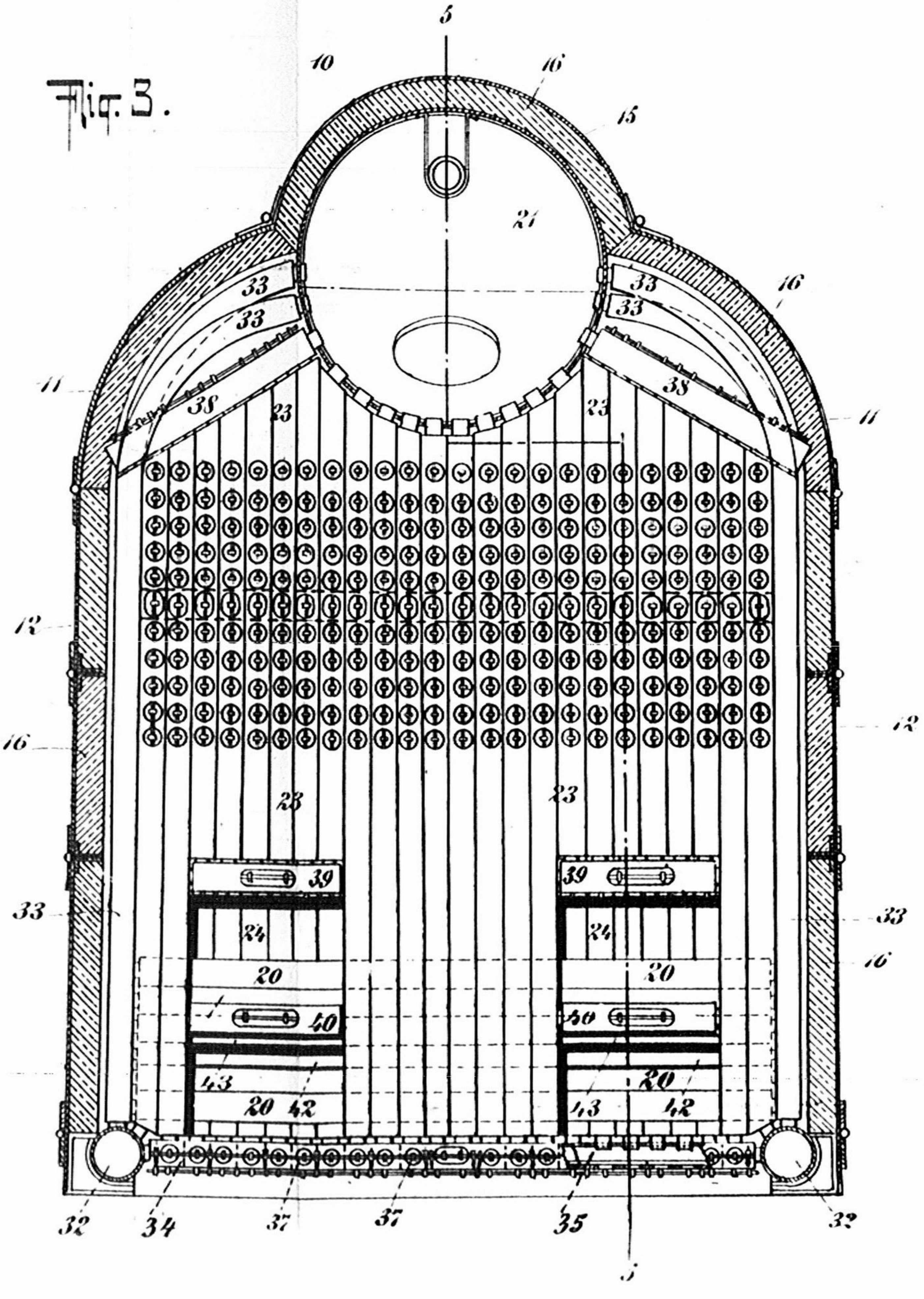
L. L. GRIFFITHS.

STEAM BOILER.

APPLICATION FILED MAR. 8, 1902.

NO MODEL. 4 SHEETS—SHEET 2.

Fig. 3.



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No. 743,271. PATENTED NOV. 3, 1903.

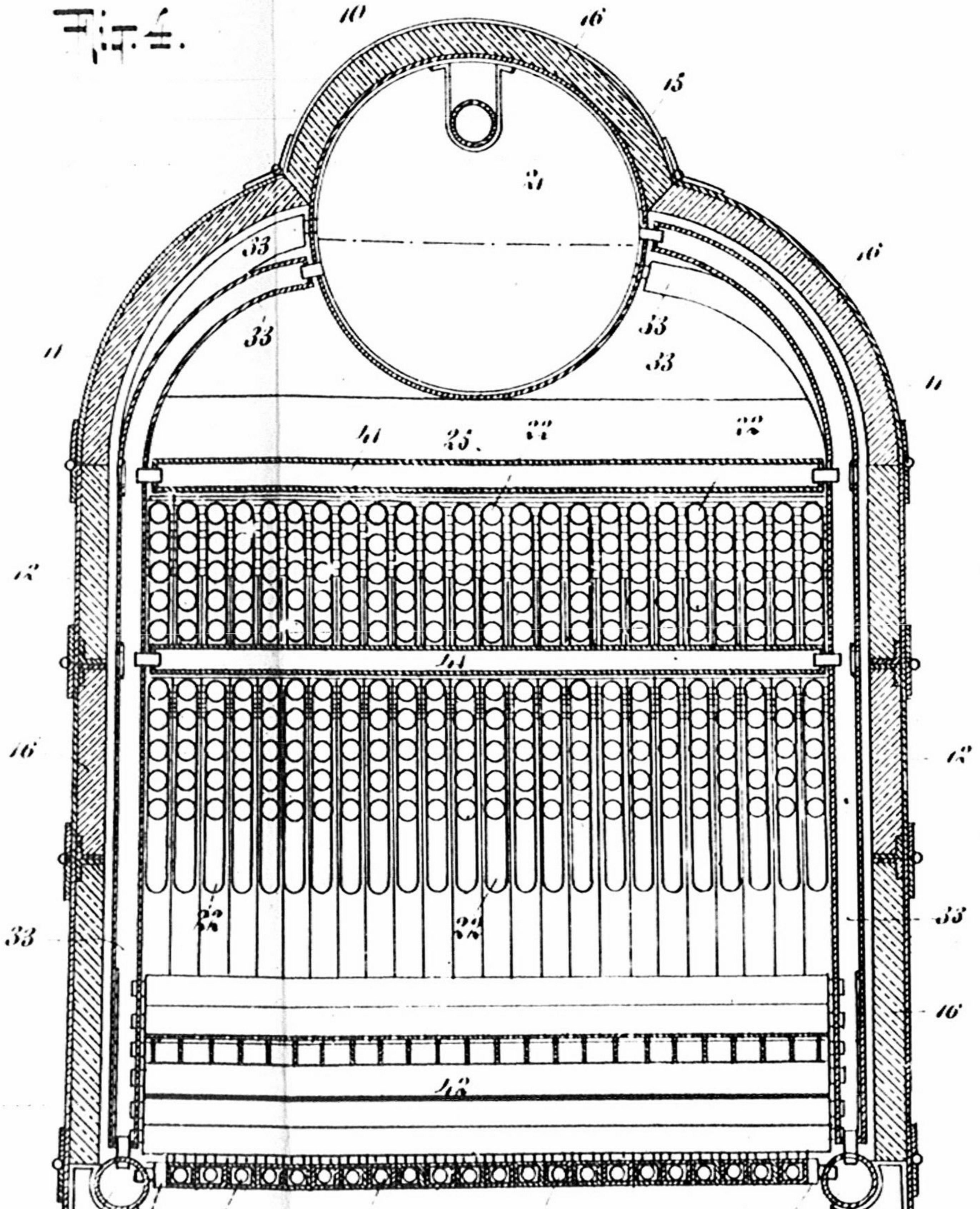
L. L. GRIFFITHS.

STEAM BOILER.

APPLICATION FILED MAR. 8, 1902.

NO MODEL. 4 SHEETS—SHEET 3.

Fig. 4.



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No. 743,271. ~~PATENTED NOV. 3, 1903.~~

L. L. GRIFFITHS.

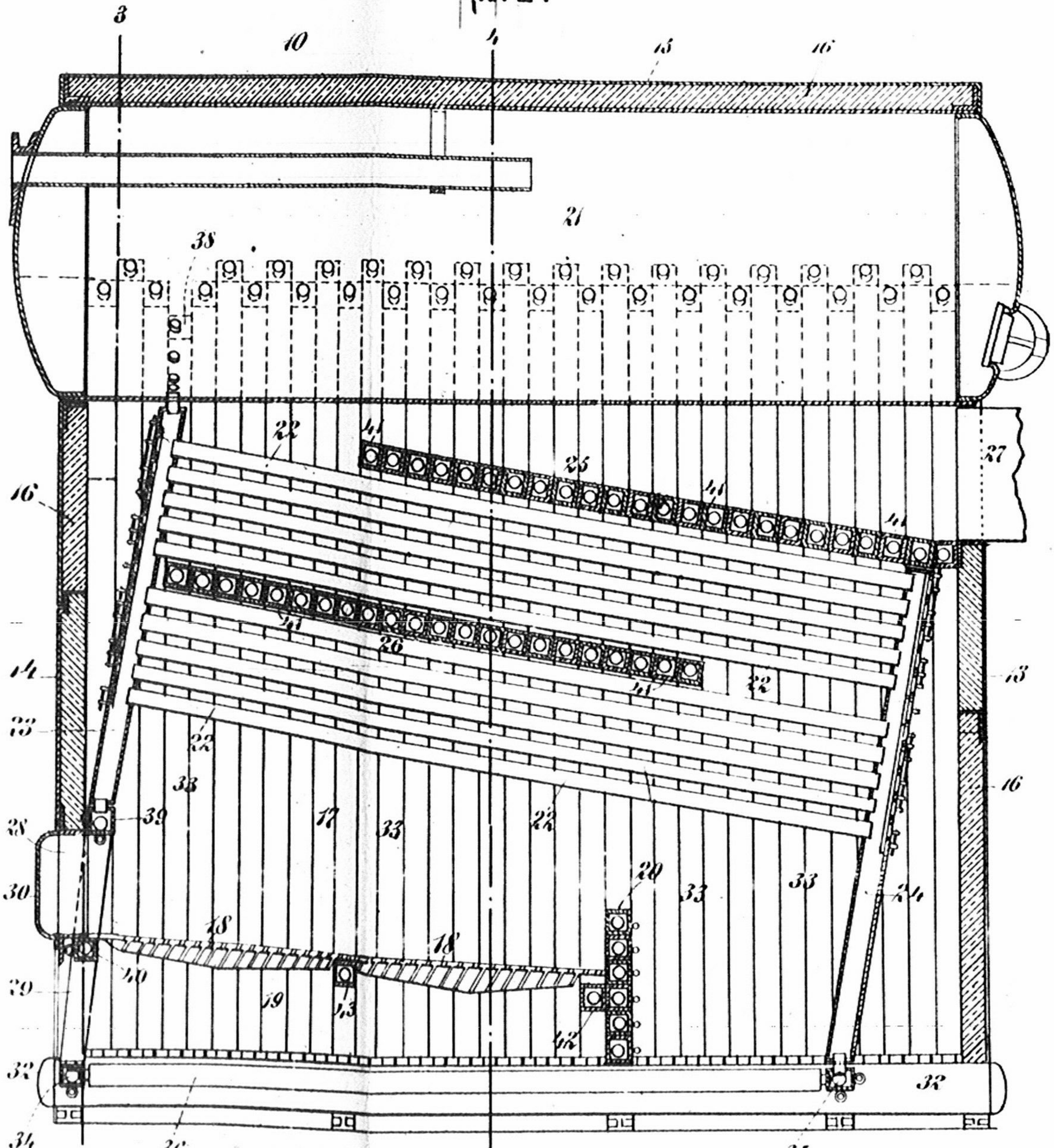
STEAM BOILER.

APPLICATION FILED MAR. 8, 1902.

NO MODEL.

4 SHEETS—SHEET 4.

Fig. 5.



Witnesses
Edwin H. Dieterich.
Gustave Dieterich

Leonard L. Griffiths
Inventor
by C. Augustus Dieterich
his Attorney.

No. 743,271. Patented November 3, 1903.

UNITED STATES PATENT OFFICE.

LEONARD L. GRIFFITHS, OF BROOKLYN, NEW YORK.

STEAM-BOILER.

SPECIFICATION forming part of Letters Patent No. 743,271, dated November 3, 1903.

Application filed March 8, 1902. Serial No. 97,264. (No model.)

To all whom it may concern:

Be it known that I, LEONARD L. GRIFFITHS, a citizen of the United States, residing at the city of New York, borough of Brooklyn, Kings county, in the State of New York, have invented certain new and useful Improvements in Steam-Boilers, of which the following is a full, clear, and exact specification.

My invention relates to improvements in steam-boilers; and the same has for its object more particularly to provide an internally-fired sectional water-tube boiler presenting increased heating-surface and capable of holding a large body of self-contained water separated into numerous small volumes, whereby to insure rapid evaporation and production of dry steam, induce a more perfect circulation of water, and yield a steady water-line.

Further, the invention has for its object to reduce the cost of construction and erection of the boiler.

Further, the invention has for its object to provide an inner casing, bridge-wall, and baffle-plates of novel construction.

The objects above set forth I am enabled to attain by means of my invention, which consists in the novel details of construction and in the combination, connection, and arrangement of parts hereinafter described, and then pointed out in the claims.

In the accompanying drawings, forming part of this specification, wherein like letters of reference indicate like parts, Figure 1 is a front view illustrating a steam-boiler made in accordance with and embodying my invention. Fig. 2 is a side view thereof. Fig. 3 is an enlarged transverse section taken on the line 3 3 of Fig. 5, showing the interior construction of the boiler. Fig. 4 is a similar view taken on the line 4 4 of Fig. 5, and Fig. 5 is a longitudinal section taken on the line 5 5 of Fig. 3.

In said drawings, 10 designates the boiler, comprising an outer casing 11, consisting of sides 12 12, back 13, front 14, and top 15, all composed of metal sections suitably secured together upon their outer surfaces and provided upon their inner surfaces with a lining 16 of asbestos or other fireproof material. 17 denotes the fire-space of the boiler; 18, the grate; 19, the ash-pit; 20, the bridge-wall; 21, the steam-drum; 22, the horizontal inclined water-tubes supported at their forward ends in headers 23 and at their rear ends in headers 24. 25 and 26 denote baffle-plates supported transversely above and between said horizontal inclined water-tubes 22, and 27 denotes the uptake.

28 denotes the fuel-supply openings, and 29 the ash-pit openings, which are provided with the customary doors 30 and 31.

In the lower portion of the boiler adjacent to the sides 12 12 are supported mud-drums 32.

Within the outer casing 11, adjacent to the sides 12 12, are disposed square water-tubes 33, which are arranged side by side closely together to form smooth unbroken walls and provided at their upper and lower ends with nipples. The nipples at the lower ends of the square tubes 33 are secured within the upper surfaces of the mud-drums 32, and the upper ends of said tubes 33 curved inwardly, and the nipples at the ends thereof secured in the steam-drum 21, alternately above and below the water-line thereof.

Within the mud-drums 32, near their forward and rear ends, are secured the nipples of the square transverse header-tubes 34 and 35, respectively, and into the inner opposing sides of the transverse headers 34 and 35 are secured the nipples of the square tubes 36, which tubes are arranged closely together and constitute the smooth base of the inner casing of the boiler, and 37 denotes hand-hole covers provided in the outer surfaces of the transverse headers 34 and 35 in lines with the tubes 36, secured in said transverse headers.

From the forward transverse header 34 extend upward and inward the vertical square headers 23, the upper ends of which nipple into the lower portion of the steam-drum 21, and the short inclined headers 38, the upper ends of which also nipple into the steam-drum 21, while the lower ends of each nipple into the upper ends of one of the square tubes 33, arranged at each side of the boiler.

Within the rear sides of the vertical headers 23 are secured and supported the forward ends of the cylindrical water-tubes 22.

39 and 40 respectively denote short horizontal headers arranged in the front vertical headers 23 above the fuel-supply openings 28 and ash-pit openings 29. Said short horizon-

tal headers 39 and 40 and the vertical headers 23 are provided with suitable hand-holes and covers to permit of access to the interior of said headers and the tubes nippling into the same.

From the rear square transverse header 35 extend upward and rearward the vertical headers 24, in the inner sides of which are secured and supported the rear ends of the cylindrical water-tubes 22. The rear surfaces of said vertical headers are also provided with suitable hand-holes and covers.

The baffle-plates 25 and 26 are arranged above the rear ends of the horizontal water-tubes 22 and between the upper and lower sections of said tubes 22 at their forward ends, and consist of square tubes 41, arranged side by side closely together to form smooth plates which are disposed transversely to the horizontal water-tubes 22. The ends of the baffle-plate tubes 41 are provided with nipples which are secured within the inner opposing sides of the vertical tubes 33, extending upward from the mud-drums 32 and constituting the sides of the inner casing of the boiler. The bridge-wall 20 is also composed of square tubes 42, which are superposed one above the other, forming a smooth unbroken wall and nippling at their ends into the inner surfaces of the square vertical tubes 33.

At the front of the bridge-wall 20, near its middle, is arranged a square tube 42, and about midway of the distance between the bridge-wall 20 and the front wall is arranged a similar tube 43, both of which nipple into the inner surfaces of the square tubes 33 and serve as supports for the grate 18.

It is to be observed that in the construction herein shown and described the products of combustion in passing through the boiler from the grate to the uptake are throughout their entire course of travel always impinging against or in contact with the direct heating-surfaces, and that the entire fire-space of the boiler being inclosed by water-tubes which communicate with the steam-drum the loss of heat by radiation is reduced to a minimum, and, further, that by separating the body of water into many small volumes surrounding the fire-space the rapid production of steam and a steady circulation of the water is insured.

Without limiting myself to the details of construction, which may be varied without departing from the spirit of my invention, what I claim, and desire to secure by Letters Patent of the United States, is—

1. A steam-boiler comprising an outer casing, grate, a steam-drum, a group of boiler-tubes, a bridge-wall and baffle-plates composed of water-tubes arranged within said outer casing, and an inner casing composed of water-tubes forming continuous smooth walls communicating with said steam-drum, mud-drum, bridge-wall and baffle-plates, substantially as specified.

2. A steam-boiler comprising an outer casing, grate, a steam-drum, mud-drum, boiler-tubes, a bridge-wall and baffle-plates composed of water-tubes arranged transversely to said boiler-tubes, and an inner casing and base composed of water-tubes forming continuous smooth walls communicating with the steam-drum, mud-drums, bridge-wall and baffle-plates, substantially as specified.

3. A steam-boiler comprising an outer casing, grate, a steam-drum, mud-drums, boiler-tubes, a bridge-wall and baffle-plates composed of water-tubes forming plates having smooth unbroken surfaces arranged transversely to the boiler-tubes, and an inner casing composed of vertical and horizontal water-tubes forming smooth continuous walls communicating with the steam and mud drums, baffle-plates and bridge-wall, substantially as specified.

4. A steam-boiler comprising an outer casing, a grate, steam-drum, mud-drums, horizontal boiler-tubes, and a bridge-wall and baffle-plates composed of water-tubes, square transverse headers secured in the mud-drums adjacent to the forward and rear ends, square water-tubes arranged side by side at the base of the boiler and nippling into the square transverse headers intermediate the ends of the mud-drums, square water-tubes arranged side by side and nippling at their lower ends into the upper sides of the mud-drums, and at their upper ends into the steam-drum, and communicating intermediate their upper and lower ends with the ends of the square tubes constituting the baffle-plates and bridge-wall secured therein, square vertical headers nippling at their lower ends into the square transverse headers intermediate the mud-drums; said vertical headers communicating with the horizontal boiler-tubes, and the forward headers communicating at their upper ends with the steam-drum, substantially as specified.

Signed at the city of New York, borough of Brooklyn, Kings county, in the State of New York, this 1st day of March, 1902.

LEONARD L. GRIFFITHS.

Witnesses:
J. E. DUNWOODY,
BENJ. ELY BERRY.

H. JUNKERS.
WALL FOR COMBUSTION CHAMBERS.
APPLICATION FILED DEC. 30, 1913.

1,125,113. Patented Jan. 19, 1915.

Fig. 1.

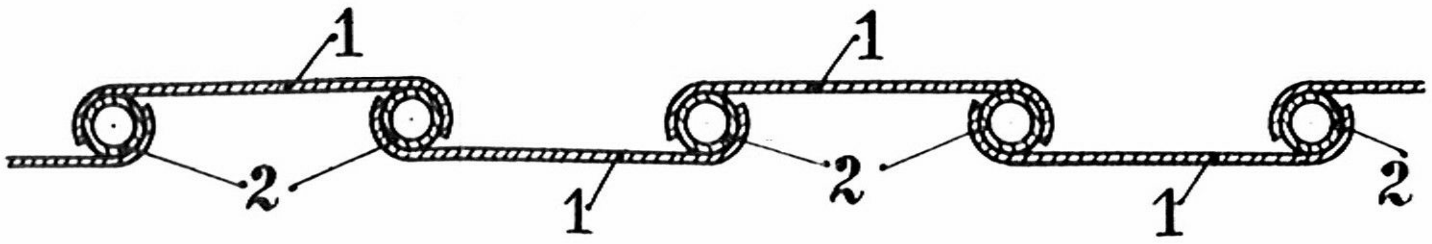


Fig. 2.

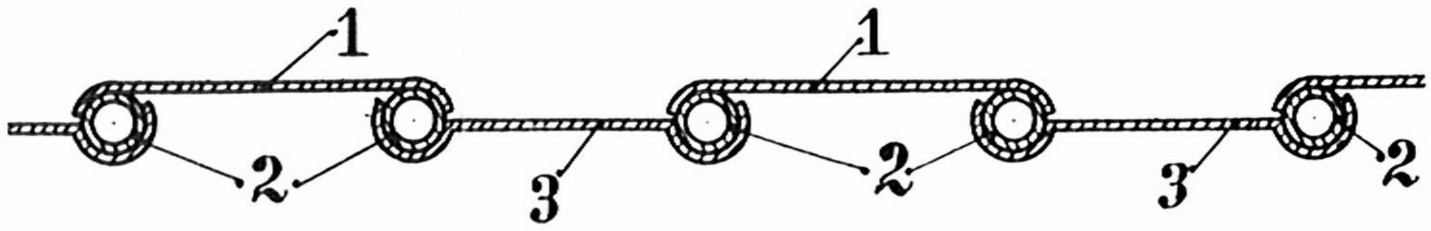


Fig. 3.

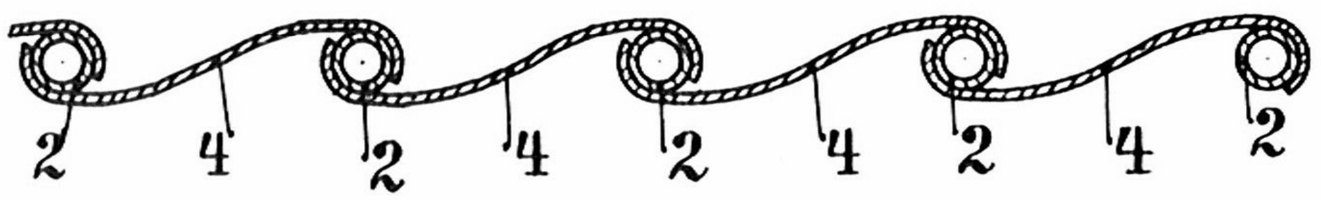


Fig. 4.

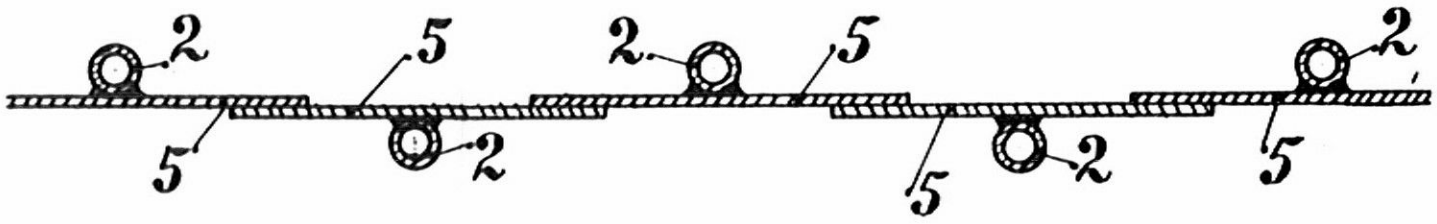
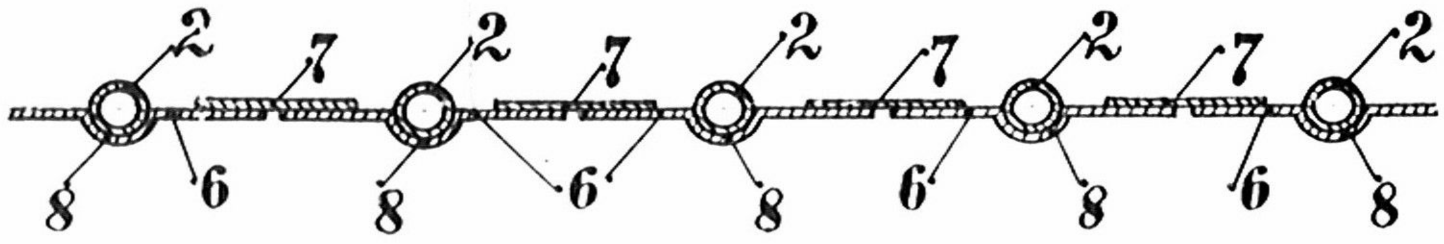


Fig. 5.



Witnesses:
C. B. Schroeder
M. D. Bunn

Inventor:
Hugo Junkers
By Pennie Davis & Goldsborough
Attys.

UNITED STATES PATENT OFFICE.

HUGO JUNKERS, OF AACHEN, GERMANY.

WALL FOR COMBUSTION-CHAMBERS.

1,125,113. Specification of Letters Patent. **Patented Jan. 19, 1915.**

Original application filed May 21, 1907, Serial No. 374,851. Divided and this application filed December 30, 1913. Serial No. 809,468.

To all whom it may concern:

Be it known that I, HUGO JUNKERS, a subject of the King of Prussia, residing at No. 68 Bismarckstrasse, Aachen, in the Kingdom of Prussia, Empire of Germany, have invented certain new and useful Improvements in Walls for Combustion-Chambers; and I do hereby declare the following to be a full, clear, and exact description of the invention, such as will enable others skilled in the art to which it appertains to make and use the same.

This invention is directed to the provision of an improved construction for the walls of combustion chambers, such for instance, as a chamber having tubes in the walls thereof for a cooling medium or a chamber having tubes in the walls thereof for a liquid to be heated.

The invention is of particular utility in the construction of walls for liquid heaters of the type shown in Patent No. 1,085,341 granted to me January 27th, 1914, and this application is a division of the application for that patent which latter application was filed May 21, 1907, and serially numbered 374,851.

The invention involves the provision of a wall for a combustion chamber consisting of a plurality of sheet-metal strips which are secured together at their lengthwise edges and arranged in the same general plane so as to form a wall, and a plurality of tubes for a liquid extending lengthwise of the strips and secured thereto. By constructing the wall in this manner, strips all of the same shape may be employed in the construction of combustion chambers differing in size and shape, the number and relative positions of the strips being varied as may be required to give the particular shape of combustion chamber desired. The strips are preferably provided with one or more lengthwise grooves in which the tubes are received, the tubes being secured to the strips so as to facilitate the transmission of heat to or from the liquid in the tubes. Each strip may have two grooves formed therein adjacent to its lengthwise edges, and in assembling the parts each tube may be laid in the grooves at the adjacent edges of two adjacent strips, the strips being secured to opposite sides of the tube. In the latter case, the two grooves in each strip may be on the same side or upon opposite sides of the strip, and when the grooves are on opposite sides, each strip will be of S-shape.

I have illustrated certain embodiments of my invention in the accompanying drawings in which—

Figures 1 to 5 are cross-sectional views of five different forms of walls for combustion chambers.

Referring to Fig. 1, the wall is shown as consisting of a plurality of sheet-metal strips (1), each of which has the metal at its lengthwise edges curved so as to form grooves adjacent to those edges. The grooves so formed are adapted to receive tubes (2). The several strips (1) are arranged to face alternately in opposite directions so that the curved edges of two adjacent strips will coact with a tube. Each tube (2) is secured to the portions of the strips (1) in contact therewith so that a wall is formed consisting of alternating strips (1) and tubes (2). The several strips (1) lie in the same general plane so as to form a wall, and the number and relative arrangement of the strips and tubes may be varied as is required to give the chamber the size and shape desired. It will be seen that each tube (2) is almost completely encircled by the curved edge portions of the strips (1), so that the transmission of heat to or from the medium within the tube takes place more readily.

Fig. 2 shows a construction closely similar to that shown in Fig. 1. This construction differs from the Fig. 1 construction in that alternate strips (3) of the wall have their edge portions curved so as to extend a greater distance around the tubes (2); by constructing the plates (3) in this manner the tubes are more completely inclosed and the space within the combustion chamber is slightly enlarged.

In Figs. 1 and 2, the curved lengthwise grooves in each sheet-metal strip face in the same direction. In Fig. 3, each strip (4) is formed so that the two grooves face in opposite directions, the strip being of S-shape. Each strip so formed contacts with the inner side of one tube and the outer side of the next tube. These strips (4) and tubes (2) are secured together as above described, lying in the same general plane so as to form a wall.

In Fig. 4, the several sheet-metal strips

(5) are shown as flat and secured together by having their edges over-lapped. Each of the several tubes (2) is secured to one of the strips (5) extending lengthwise thereof. If desired, all of the tubes may be upon the same side of the strips (5) of the wall, but I prefer to arrange the tubes as shown in Fig. 4, wherein alternate tubes (2) are on opposite sides of the strips (5).

In Fig. 5, the strips (6) are shown as secured together, not by having their edges over-lapped, but by having an additional strip (7) placed in contact with the adjacent edges of each pair of adjacent strips and secured thereto. In Fig. 5, each strip (6) is shown as having a lengthwise groove formed therein at about the middle of the strip as shown at (8), and the tubes (2) lie in these grooves (8) and are secured to the strips in contact therewith.

I claim:

1. In a liquid heater, a wall for the combustion chamber consisting of a plurality of sheet-metal strips secured together at their lengthwise edges and arranged in the same general plane so as to form a wall, and a plurality of liquid-containing tubes extending lengthwise of the strips and secured to the strips in contact therewith, substantially as described.

2. In a liquid heater, a wall for the combustion chamber consisting of a plurality of sheet-metal strips secured together at their lengthwise edges and arranged in the same general plane to form a wall, each of said strips having a curved groove therein extending in the direction of the length of the strip, and a plurality of liquid-containing tubes extending lengthwise of the strips in the grooves therein and secured to the strips in contact therewith, substantially as described.

3. In a liquid heater, a wall for the combustion chamber consisting of a plurality of sheet-metal strips each having grooves formed therein at its lengthwise edges, and a plurality of tubes each lying in the grooves at the adjacent edges of two adjacent strips of the wall and secured to said strips, substantially as described.

4. In a liquid heater, a wall for the combustion chamber consisting of a plurality of sheet-metal strips each having grooves formed therein at its lengthwise edges, the two grooves in each strip facing in opposite directions, and a plurality of tubes each lying in the grooves at the adjacent edges of two adjacent strips of the wall and having its opposite sides secured to the two strips, substantially as described.

In testimony whereof I have signed my name to this specification in the presence of two subscribing witnesses.

HUGO JUNKERS.

Witnesses:
MAX KLOSS,
HEINRICH ZIMMERMANN.

and to said barrel, crown drums, and arch tubes extending from said header to said crown drums.

13. The combination with a barrel 1 of a header 35 extending transversely of said barrel beneath the same and formed to present projections 117, a plurality of crown drums, and arch tubes connected directly to said drums and projections.

14. In a fire-box the combination with a barrel 1 of a flue sheet 7 having a smooth terminal, crown drums 9 and 11 overlying said terminal having main body portions of inherent pressure resisting form, and means 15, 17 and 19 for closing spaces between said drums, sheet and barrel.

15. In a fire-box the combination with a barrel 1 of a flue sheet 7 having a smooth upper terminal, a rear wall comprising tubes 57 and 71 collectively presenting a smooth upper terminal, and crown drums above said flue sheet and rear wall having body portions of inherent pressure resisting shape and end closure means 15, 17, 19 and 51 for the spaces between said drums and terminals.

16. The combination of a barrel 1 with crown drums 9 and 11, a flue sheet 7 fitting said barrel and terminating at the under sides of said drums, and means 13, 15, 17 and 19 for closing spaces between said drums and the flue sheet and barrel.

17. In a fire-box a crown comprising a plurality of drums 9 and 11 having flattened sides secured together and extruded portions 13, 15, 17 and 19 forming part of the end closure of the fire-box.

18. A fire-box for a boiler including a plurality of crown drums placed side by side and having closed rear ends distorted to provide flat abutting surfaces whereby the drums fit together in block-like manner and form a unified, substantially continuous surface.

19. A boiler fire-box having a water containing enclosing section comprising a plurality of hollow members each having a wall of substantially uniform thickness and having a rounded, pressure-resisting section, said members having closed end portions distorted to fit together in block-like manner to form a unified, substantially continuous, marginal surface for the enclosing section.

20. A boiler comprising a barrel and a fire-box, the fire-box including crown drums communicating with the upper portion of said barrel and having closed rear ends, the lower portions of said drums at each end being distorted to fit together and present substantially straight lower boundaries, a flue sheet fitting one of said boundaries and cooperating with said drums to close the end of the barrel and a rear wall for the fire-box beneath the other said boundary and including water containing tubes in communication with said drums.

21. In a firebox a crown chamber comprising a plurality of generally cylindrical drums having flattened sides fitting together in downwardly and inwardly converging planes in the manner of voussoirs.

22. In a firebox a crown chamber comprising lateral drums having inner flattened sides disposed in inwardlv and downwardly converging planes and a central drum having flattened sides fitting those of the lateral drums and received between them in the manner of a keystone.

23. In a firebox a crown chamber comprising lateral drums having inner flattened sides disposed in inwardly and downwardly converging planes and a central drum having flattened sides fitting those of the lateral drums and received between them in the manner of a keystone, the lower portions of said drums extending substantially in a common tangent plane.

24. In a firebox a crown chamber comprising a plurality of generally cylindrical drums having flattened sides fitting together in downwardly and inwardly converging planes in the manner of voussoirs and water-containing side walls supporting the lateral drums and providing lateral abutments.

25. In a firebox a crown chamber comprising lateral drums having inner flattened sides disposed in inwardly and downwardly converging planes and a central drum having flattened sides fitting those of the lateral drum and received between them in the manner of a keystone, the rear ends of the drums being distorted to fit together block-like along said planes and provide a unified flat-sided lower margin for the rear end of the chamber.

26. In a firebox a crown chamber comprising lateral drums having inner flattened sides disposed in inwardly and downwardly converging planes and a central drum having flattened sides fitting those of the lateral drums and received between them in the manner of a keystone, the forward ends of the drums being distorted to fit together block-like along said planes and collectively to form a segmental end portion for the chamber.

In testimony whereof, I have signed my name to this specification, in the presence of two subscribing witnesses.

JAMES M. McCLELLON.

Witnesses:

HENRY T. WILLIAMS,
ROBERT H. KAMMLER.

are secured by stud bolts to upper and lower horizontal headers 65 having open ends with side wall portions 67 (Fig. 3) overlapping and welded to the tubes 57 adjacent to the ends of said frame. The side edges of said frame may be secured by stud bolts to shoulders 69 formed on said tubes.

The upper header 65 may be connected with the central crown drum by a series of short tubes 71 having reduced ends entered into apertures in said header and drum.

The lower header 65 is connected to the hollow mud-ring 58 by a series of short tubes 73 having their upper ends reduced and expanded in apertures in the lower header, and their lower ends expanded in apertures in said mud-ring.

The tubes 57, 71 and 73 may be connected by fillers 75 welded thereto, so that the assembly of tubes and fillers presents a wall forming in effect an integral whole, but with the advantages of expansion, contraction and tendency to retain its original shape, had from the tubular construction.

The union of the crown drums with the rear wall as described, provides a strong, simple construction, and enables the use of straight tubes of equal lengths at the sides of the fire-door frame, and straight tubes above and beneath said frame. The expanding of the ends of the tubes into apertures in the flat portions of the crown drums, may be very easily effected and provides a connection which reduces the likelihood of leakage to a minimum.

Each of the side walls of the fire-box comprises a series of large tubes 79 having their upper ends reduced and curved inward somewhat and entered and expanded into apertures in the side crown drums. The lower ends of the tubes are reduced and entered into apertures in the hollow mud-ring 58 referred to.

Preferably the tubes are gradually reduced in length from the flue-sheet to the rear wall. The portions of the mud-ring extending from said flue-sheet to said rear wall, are inclined as well shown in Fig. 1, to conform to the lengths of the tubes. The spaces between the side walls of the tubes may be closed by fillers 89 welded thereto, thereby forming a side wall which, in effect, is an integral whole. The side wall tubes adjacent to the flue-sheet may be connected to the barrel and the corner tubes of the side and rear walls may be connected by fillers welded thereto.

The outer faces of the side walls may be covered by asbestos or other appropriate material 87 (Fig. 2) which may be protected by a cover plate 89.

The portions of the hollow mud-ring at the sides of the fire-box may extend to and beneath the header 35 and be formed to present enlarged portions 91 (Fig. 8) overlapping and riveted or otherwise secured to said header. The ends of said side portions may be formed to present upturned lips 93 overlapping and riveted or otherwise secured to the outer face of the header 35, thereby contributing to the strength of the connection between the parts.

To permit the water to flow from the header 35 into the hollow mud-ring, they may be provided with registering apertures 95 (Figs. 7, 8 and 9). The front ends of the side portions of the mud-ring may be closed by heads 97 welded or otherwise secured thereto. Plugs 99 tapped in said heads may be removed to facilitate the cleaning of the mud-ring. The ends of the header 35 may be closed by heads 101 welded or otherwise secured therein. Plugs 103 tapped into said heads may be removed to permit the cleaning of said header.

To close the triangular-like space between the lower wall of the barrel and the upper wall of the header 35, there may be provided tiles 105 having grooves in their upper edges in which enter the heads of the circumferential row of rivets projecting outward from the barrel connecting the flue-sheet thereto. This will prevent the displacement of the upper ends of the tiles. To prevent displacement of the lower ends of the tiles a lip 107 (Fig. 1) may be formed on or be welded to and project upward slightly from the header 35 into grooves in the lower edges of said tiles.

To close the space between the side portions of the mud-ring beneath the header, a plate 108 (Fig. 1) may be secured to and depend diagonally rearward from said header. A series of tiles 109 are supported on ribs 111 projecting upward from said plate and on an angle-bar 113 secured to said plate. The ribs 111 provide desirable air spaces between the tiles and the plate, thereby tending to prevent overheating of the former.

A series of arch tubes 115 may be provided having their lower ends expanded into projections 117 (Figs. 1, 6 and 7) pressed outward at intervals from the inner wall of the header 35. The upper ends of said arch tubes are curved and entered into the crown drums adjacent the rear wall. The projections 117 and the curvature of the tubes enables the latter to be entered into the header and drums substantially at right angles to portions thereof, thereby contributing to the strength and security of the connection. The arch tubes have tiles 120 thereon forming a baffle wall for assisting combustion of the fuel and deflecting and prolonging the flame length from the grate to the flue-sheet. The position of the grate is indicated by the broken line x—x in Fig. 1.

The crown drums may have extensions 119 (Fig. 1) projecting therefrom into the barrel connected by stay rods 121 with the upper wall of the barrel, thereby stiffening the flue-sheet.

The side walls, rear wall and crown drums provide a closure for the fire-box composed substantially entirely of tubular elements, which when welded together as described, have great strength as an assembly and effectively withstand the rack and tear which locomotive fire-boxes necessarily experience.

The tubular elements are substantially of circular cross section and as a result the high pressure strain therein does not tend to distort them, but on the contrary tends to cause them to retain their original shape, it being well known that pressure in a container tends to cause it to assume a form which is circular in cross section. Therefore said elements may be of ample cross section, providing large passages, permitting an efficient circulation of the water and steam therethrough. No stays are necessary for the tubular elements. Consequently their interiors are open and free without obstructions therein such as would invite incrustation and scale.

The forming of the crown drums to fill the spaces between them and the flue sheet and rear wall does not detract from the strength of the drums and enables the use of an extremely strong and simple flue sheet and rear wall construction.

The parts of the fire-box may be made and assembled at small expense and are not likely to get out of order and require repairs.

Having described one illustrative embodiment of the invention without limiting the same thereto, what I claim as new and desire to secure by Letters Patent, is:—

1. A boiler comprising, in combination, a barrel, crown drums side by side having end portions shaped to interfit and collectively to close a segment of the end of said barrel and a flue sheet having an edge fitting the lower parts of said end portions and closing the barrel end below such segment.

2. A boiler comprising, in combination, a barrel, a crown chamber including a plurality of drums placed side by side and having end portions collectively shaped to conform to the curvature of the barrel and fitted thereto and a flue sheet completing the closure of the barrel beneath said chamber.

3. A boiler comprising, in combination, a barrel, crown drums side by side having end portions shaped to interfit and collectively to close a segment of the end of said barrel, said segment having a smooth lower edge, and a flue sheet having a smooth upper edge fitting the lower parts of said end portions and closing the barrel end below such segment.

4. A fire-box comprising crown drums and a flue sheet having an upper end shaped differently from the body portions of said drums, the latter having end portions formed to conform to the upper end of said sheet and collectively therewith constitute an end closure for the fire-box.

5. A fire-box comprising a flue sheet having a substantially straight upper end, and crown drums placed side by side having end portions formed to conform to said straight upper end and collectively with said sheet constituting an end closure for the fire-box.

6. A fire-box comprising crown drums, a flue sheet and a rear wall both having upper ends shaped differently from the main body portions of said drums, the latter having portions formed to conform to the upper ends of said sheet and wall and collectively therewith constituting end closures for the fire-box.

7. A fire-box comprising crown drums having heads at the rear ends thereof, a flue sheet and a rear wall both having upper terminals formed differently from the main body portions of said drums, the latter having portions above said terminals formed to conform therewith and collectively constitute an end closure for the fire-box, including as a part thereof the heads for the rear ends of said drums.

8. A fire-box comprising crown drums and a flue sheet having its upper terminal beneath and shaped differently from the main body portions of said drums, the latter having extruded portions above said flue sheet and collectively therewith forming an end closure for the fire-box.

9. The combination with a barrel of crown drums having end portions shaped to conform to the contour of said barrel and secured directly to said barrel, and a flue sheet terminating at the bottoms of said drums and secured directly to said barrel and said drums.

10. The combination with a barrel of crown drums having end portions formed to fit the contour of said barrel, and a flue sheet formed to fit the contour of said barrel and terminating beneath and secured to the bottoms of said drums.

11. The combination with a barrel of a throat header extending transversely thereof directly beneath the same, directly secured thereto and forming a substantial part of the rear end closure of the fire-box beneath the barrel, and means for closing the spaces between the curved side walls of said barrel and the top side portions of the header.

12. The combination with a barrel of a mud ring closely adjacent the bottom thereof; a header extending transversely of said barrel and secured directly to said mud ring

may be provided for closing the spaces between the drums and the upper edge of the flue sheet and the top of the barrel. As shown herein the drums have portions adjacent their ends formed to conform with one another and collectively cooperate to complete the closure of said spaces. For example, the end portions of the central drum 9 adjacent the barrel may be pressed or otherwise formed to present lower corners 13 and upper corners 15. The end portions of the outer drums 11 adjacent the barrel may be pressed or otherwise formed to present lower corners 17 and upper corners 19. The corners 13 and 17 may have flat sides engaging one another, and the upper corners 15 and 19 may have flat sides engaging one another. The outer corners 17 of the side drums and the upper corners thereof may have sides preferably curved to conform to the contour of the barrel 1 referred to. The side drums may have flattened portions 27 curved gradually inward, also to conform to the contour of the barrel. The flattened portions of the meeting drums may be riveted or otherwise secured together. Preferably, the corners have their points somewhat blunt or rounded. The spaces between them may be closed by fillers 29 welded therein. The lower corners of the drums may have flat under sides preferably substantially in the same plane.

The flue-sheet 7 may be extended upward and have a flange 31 extending away from the interior of the fire-box riveted or otherwise secured to said drums and forming a line of closure with said drums. It will be seen that the crown drums collectively close a segment of the end of the barrel and the flue sheet closes the barrel below this segment. In the particular case illustrated this segment is a segment in the more restricted sense in that its base is a chord of the circular end of the barrel but obviously the base might be other than a straight line.

By the above described construction, it will be apparent the flue-sheet may be readily removed without disturbing the crown drums and that any or all of the crown drums may be removed without disturbing the flue-sheet. Also, there is a decided economy in the amount of material necessary to form the flue-sheet. The reduction in the size of the flue-sheet reduces the area which is subjected to different temperatures and reduces the likelihood of the cracking thereof from stresses set up by temperature changes. As a result, the life of the sheet is prolonged.

The shaping of the crown drums to conform to the curvature of the barrel enables the drums to be inserted as a unit directly into the barrel (Fig. 1), with margins overlapping the latter and secured thereto by rows of rivets 33 or otherwise as desired. This direct connection of the drums with the barrel eliminates the necessity of a wrapper or intermediate sheet to unite the drums with the barrel and provides an extremely strong, rigid, and compact construction.

Beneath the barrel and extending transversely to the longitudinal axis thereof, there may be provided a header 35 (Figs. 1, 6, 7, 8 and 9) which may be riveted or otherwise secured to a flattened portion 37 (Fig. 5) of the barrel.

This header may serve to assist in the closing of the space beneath the barrel and the bottom of the fire-box and to conduct water from the barrel to a hollow mud-ring to be referred to.

Water may pass from the barrel to the header through registering apertures 39, in said flattened portion of the barrel and header. Adjacent the ends of the header, water legs 41 (Figs. 5, 6 and 9) may be provided having flanges at their lower ends secured to said header and flanges at their upper ends secured to the barrel. These water legs serve to conduct water from the barrel to the header and also materially strengthen the connection between them.

The curved sides and bottom of the flue sheet may have a flange 43 projecting away from the interior of the fire-box into the barrel and riveted or otherwise secured thereto.

The header may have depressions 45 (Figs. 1, 7 and 9) formed therein opposite to the driving wheels 47 of the locomotive, thereby permitting the header to be arranged closely adjacent to said wheels, but without interference therewith.

Suitable means is provided for closing the spaces between the end portions of the drums adjacent the rear wall. To accomplish this the crown drums may be pressed or otherwise formed to present corners 51. The inner corners of the adjacent sides of the drums may have flat sides riveted or otherwise secured together. The under sides of said corners may be flat and lie substantially in one and the same plane. The rear ends of the crown drums may be closed by bumped heads 53, the outer drums being provided with manholes having covers 55.

The rear wall of the fire-box may comprise a series of upright tubes 57 (Fig. 2) having their upper ends reduced and expanded in apertures in the under sides of the crown drums. The lower ends of said tubes may be expanded in apertures in a hollow mud-ring 58, preferably U-shaped in form (Fig. 1), and having a bottom 61 welded or otherwise secured therein and provided with a series of apertures opposite the tubes closed by removable plugs 62 tapped therein to permit access to said tubes for purposes of replacement or repair.

In the rear wall is a frame (Figs. 2, 3 and 4) having an elliptic-like door opening 63. The upper and lower margins of said frame

Patented Nov. 13, 1923. **1,474,156**

UNITED STATES PATENT OFFICE.

JAMES M. McCLELLON, OF EVERETT, MASSACHUSETTS; HAROLD B. McCLELLON ADMINISTRATOR OF SAID JAMES M. McCLELLON, DECEASED.

BOILER.

Application filed September 29, 1915, Serial No. 53,165. Renewed April 11, 1923.

To all whom it may concern:

Be it known that I, JAMES M. McCLELLON, a citizen of the United States, and a resident of Everett, county of Middlesex, and State of Massachusetts, have invented an Improvement in Boilers, of which the following description, in connection with the accompanying drawings, is a specification, like characters on the drawings representing like parts.

This invention relates to fire-boxes and among other objects aims to provide a strong, simple, compact and efficient fire-box for locomotives.

The character of the invention may be best understood by reference to the following description of an illustrative embodiment thereof shown in the accompanying drawings, wherein,—

Fig. 1 is a vertical, longitudinal section through an illustrative fire-box embodying the invention;

Fig. 2 is a rear elevation of the construction shown in Fig. 1;

Fig. 3 is a horizontal section taken on line 3—3 of Fig. 2;

Fig. 4 is a horizontal section taken on line 4—4 of Fig. 2;

Fig. 5 is a vertical, transverse section taken on line 5—5 of Fig. 1;

Fig. 6 is a side elevation of a portion of the barrel, crown drums and hollow mud-ring;

Fig. 7 is a vertical detail section taken on line 7—7 of Fig. 8;

Fig. 8 is a horizontal detail section taken on line 8—8 of Fig. 6; and

Fig. 9 is a vertical detail section taken on line 9—9 of Fig. 6.

Referring to the drawings, the illustrative construction shown therein as embodying the invention, comprises a barrel 1 (Figs. 1 and 7) containing the usual steam generating flues 3 and superheating tubes 5. The rear ends of said tubes and flues are expanded into apertures in a flue-sheet 7.

The illustrative crown of the fire-box comprises a central drum 9 and drums 11 at the opposite sides thereof. The adjacent sides of the drums may be flattened somewhat and riveted or otherwise secured together, as well shown in Fig. 5. As appears from said figure the mating flattened sides of the drums are disposed in planes which converge downwardly and inwardly and thus the central drum sets in between the two lateral drums in the manner of the keystone of an arch and the entire crown chamber comprising the three drums is an arch-like construction, the drums corresponding to the voussoirs, and the lateral drums are supported by the side wall tubes 79 hereinafter referred to constituting lateral abutments. The exposed surfaces of the drums are cylindrical surfaces and thus well adapted to resist pressure and preferably, as clearly seen in Fig. 5, the lower portions extend downwardly substantially to a common tangent plane. There is thus provided a large heating surface at the under side of the crown chamber while the joining of the drums along the adjacent flattened surfaces as described not only provides for a solid structure adapted to resist the racking strains due to the locomotive passing over the road but permits the level of water in the crown to be lowered to a considerable degree without exposing any surface uncooled by water to the heat of the fire.

Heretofore the flue-sheet has been extended up beyond the crown drums and the latter have been entered through apertures therein. This made it necessary to reduce the end portions of the drums adjacent said sheet to allow sufficient flue-sheet material between said drums, and to form the flue-sheet to present flanges encircling said drums. The flanges were secured to said drums by rows of rivets extending throughout the circumferences thereof. The dieing out of the apertures, and the fitting, shaping and riveting together of the parts made this construction costly to manufacture. Furthermore, if it was desired to remove the flue-sheet for purposes of replacement or repair, it was necessary to remove all the rivets in the entire circumferences of the flue-sheet flanges surrounding the drums, and in reassembling it was necessary to fit the ends of the drums into the openings in the flue-sheet and to repeat the operation of riveting to secure the same together.

One of the objects of the present invention is to provide a simple and effective construction which avoids the objections referred to. To accomplish this the flue sheet may extend up to the crown drums and suitable means

Nov. 13, 1923. J. M. McCLELLON **1,474,156**

BOILER

Original Filed Sept. 29, 1915 4 Sheets-Sheet 4

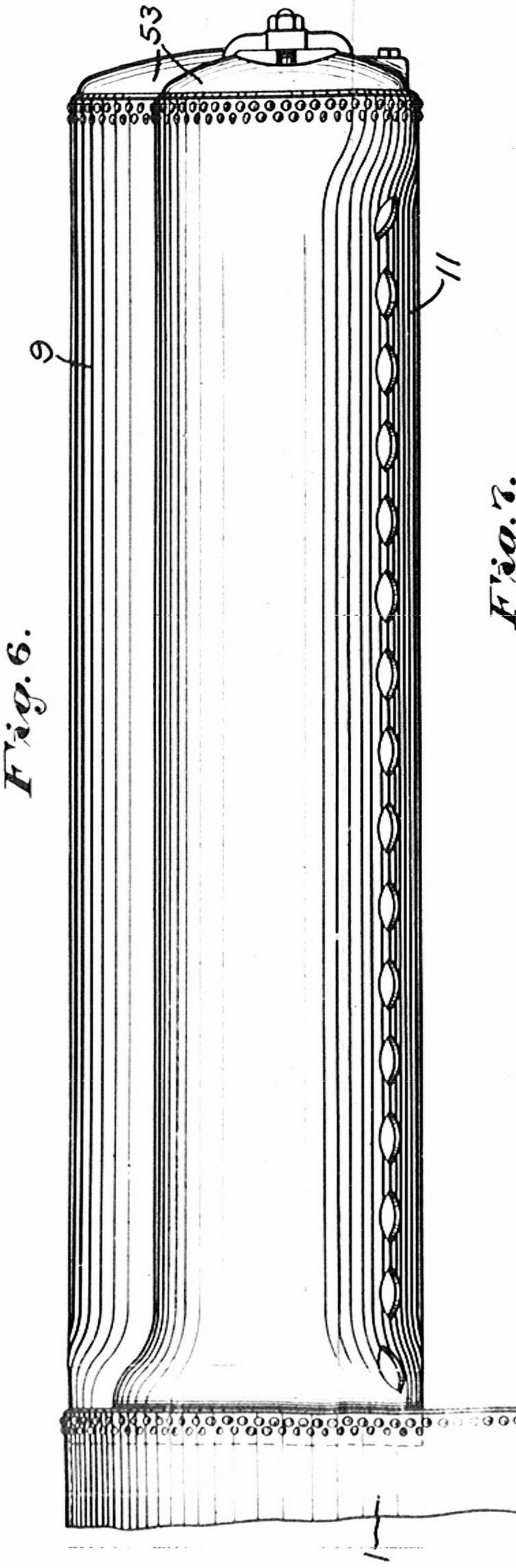


Fig. 6.

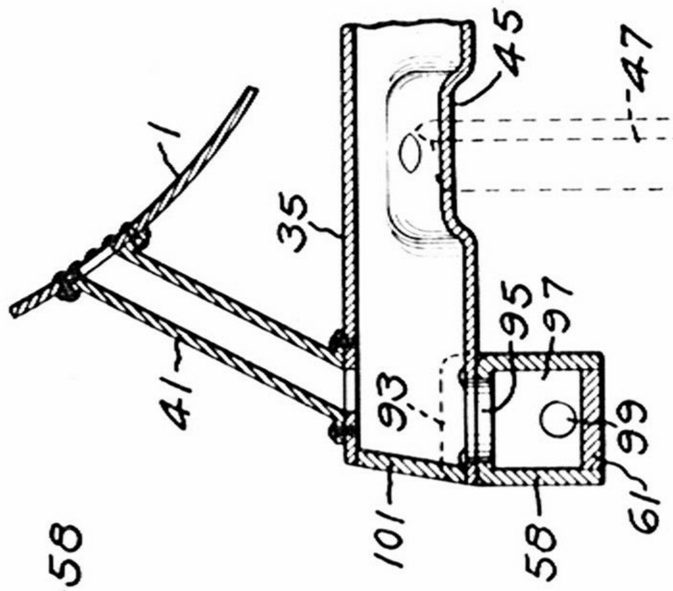


Fig. 9.

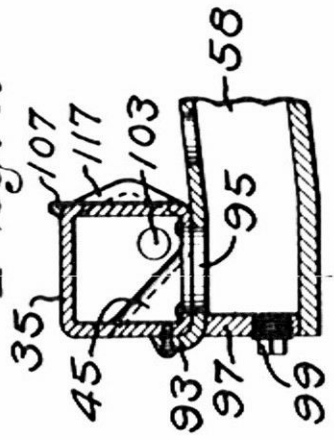


Fig. 7.

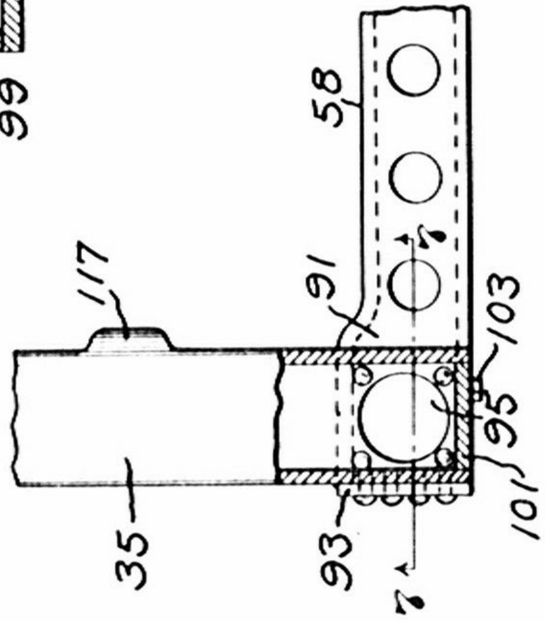


Fig. 8.

Inventor:
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by Emery, Booth, Janney & Varney
Att'ys.

Nov. 13, 1923. J. M. McCLELLON 1,474,156

BOILER

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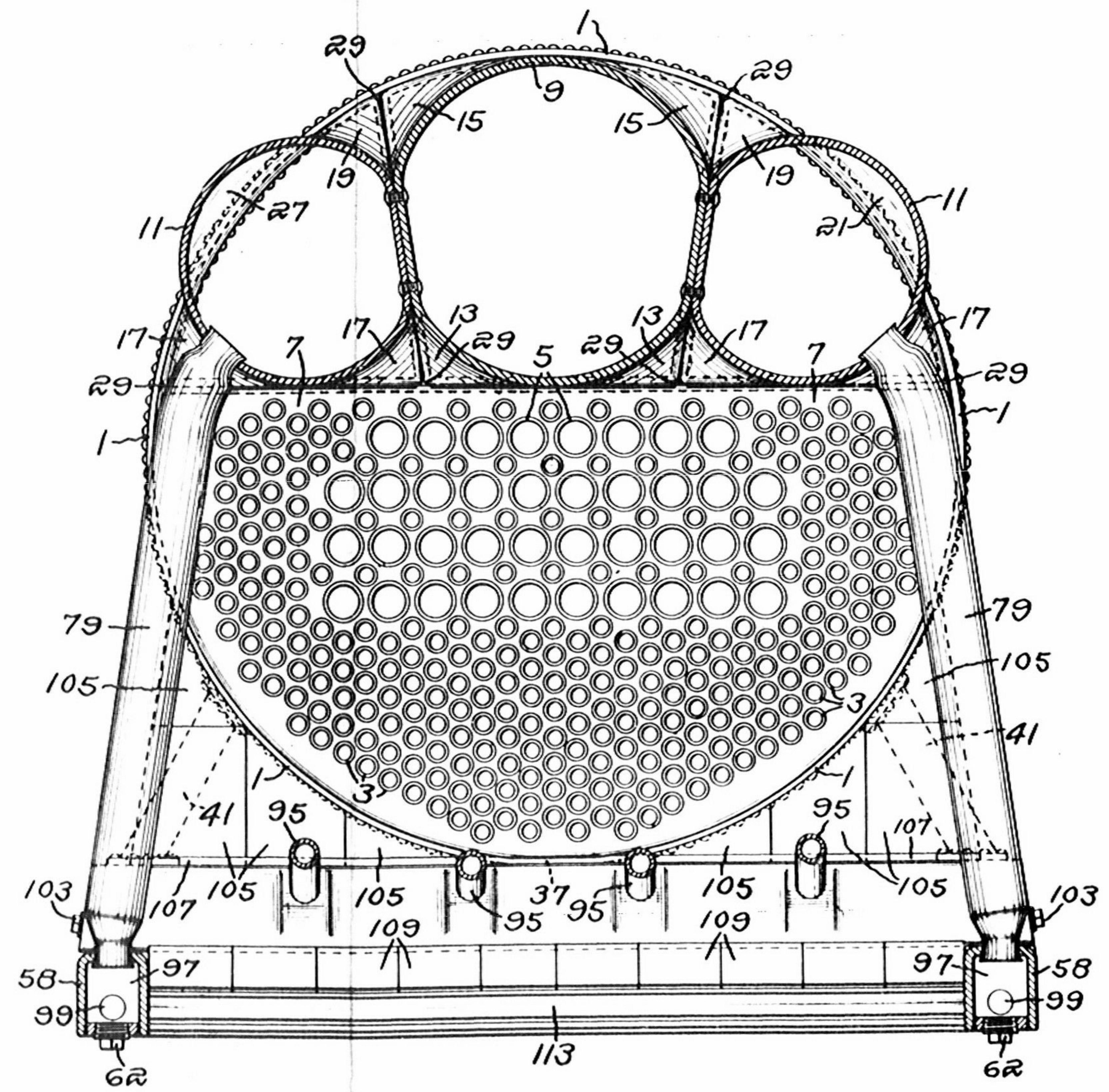
Fig. 3.



Inventor:
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by Emery, Booth, Janney & Varney
Attys.

Nov. 13, 1923.

J. M. McCLELLON

1,474,156

BOILER

Original Filed Sept. 29, 1915 4 Sheets-Sheet 2

Fig. 2.

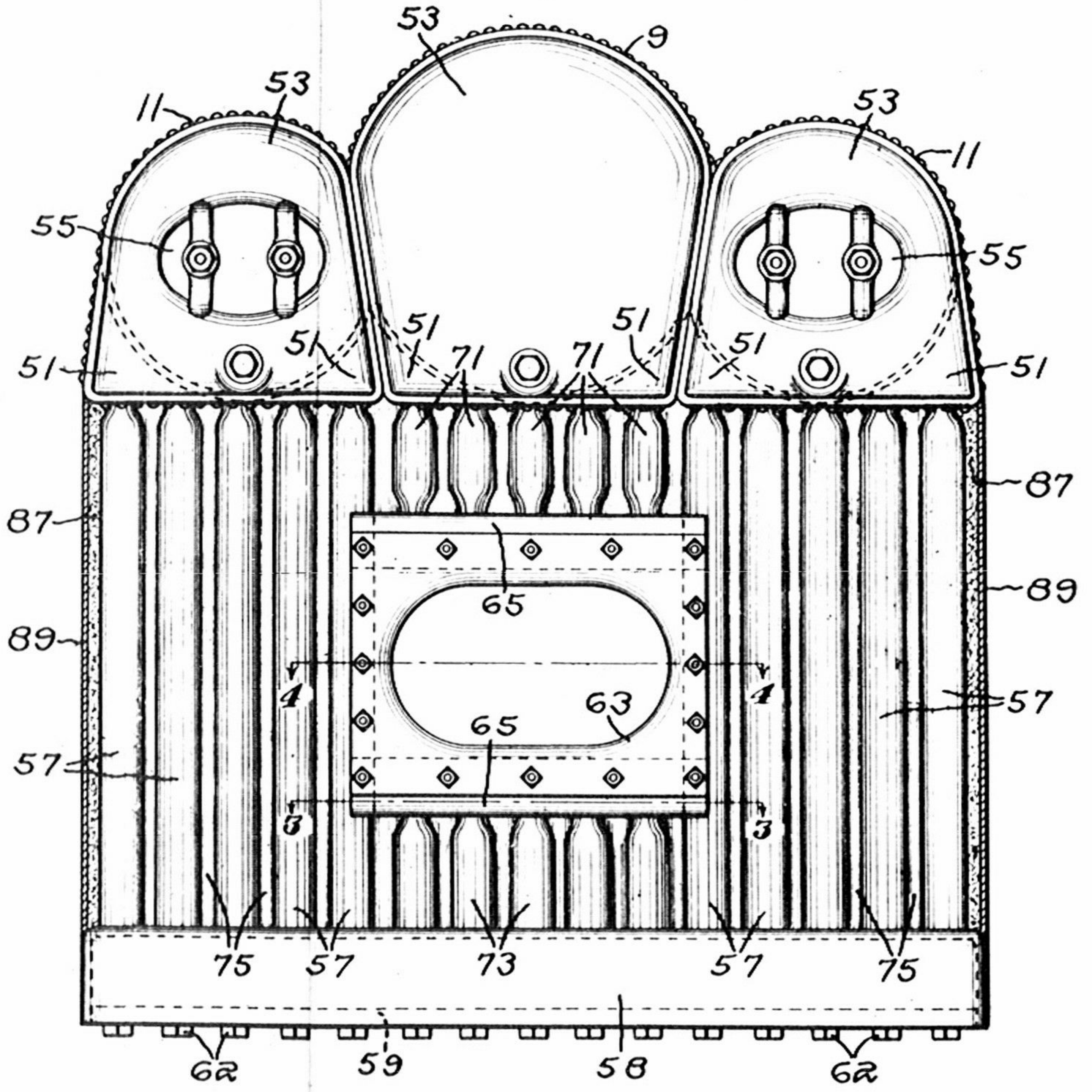


Fig. 3.

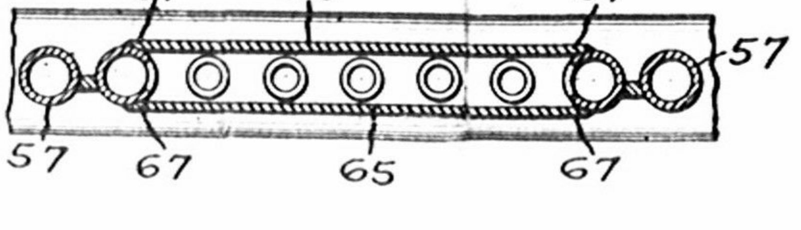
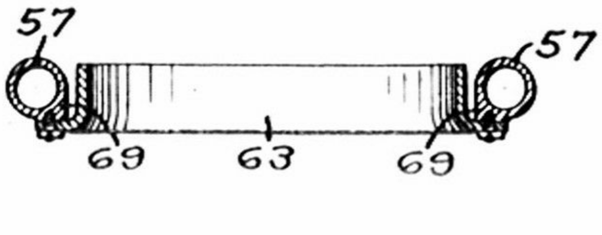


Fig. 4.



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Nov. 13, 1923. 1,474,156

J. M. McCLELLON

BOILER

Original Filed Sept. 29, 1915 4 Sheets-Sheet 1

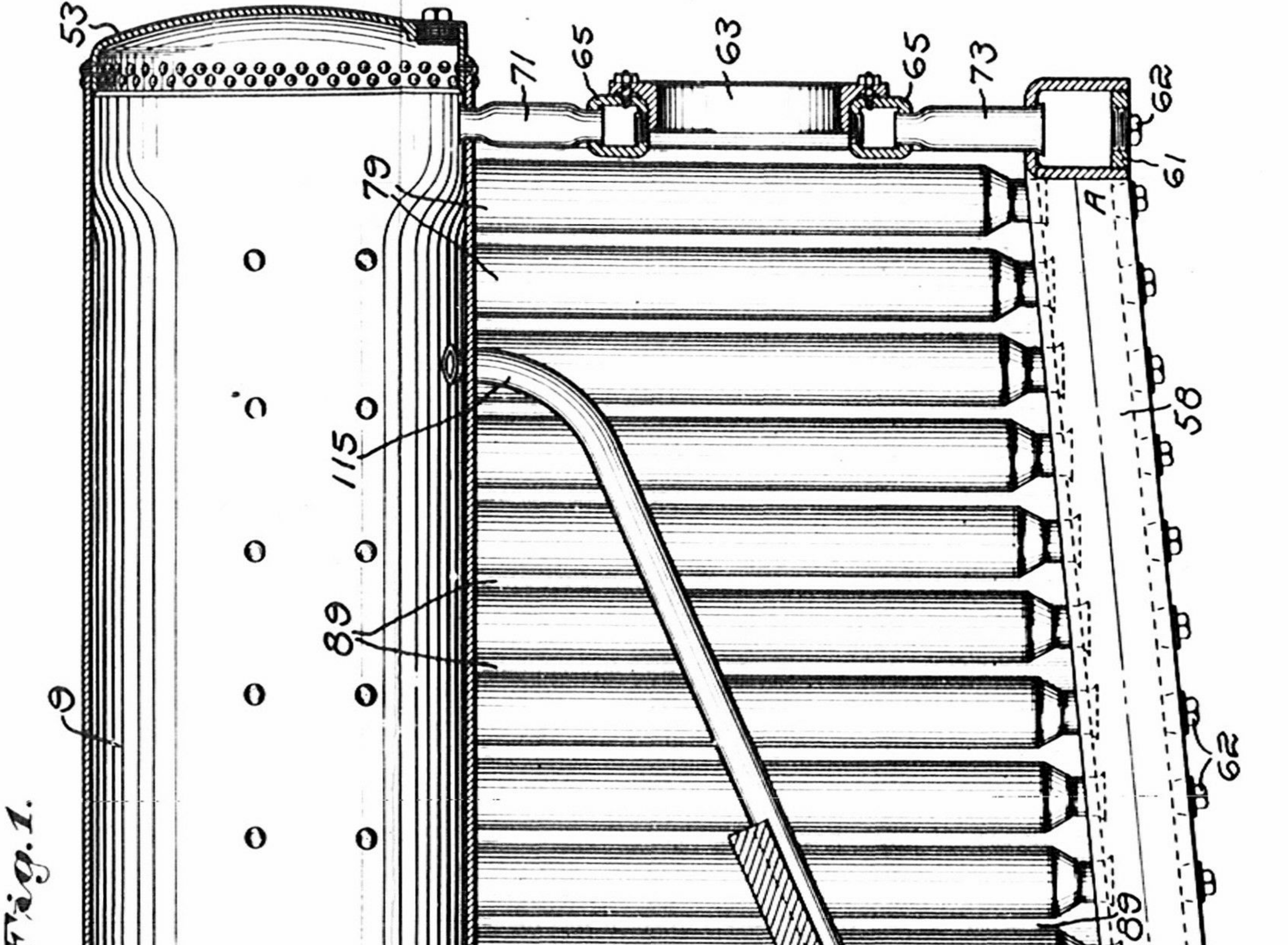

Fig. 1.

Inventor:
James M. McClellon,
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Att'ys.

IN THE SUPREME COURT OF THE
DISTRICT OF COLUMBIA

Metropolitan Engineering Co., :
Plaintiff, :
: In Equity
v. : No. 51,977
Conway P. Coe. :
Defendant. :

PLAINTIFF'S EXHIBIT NO. 18

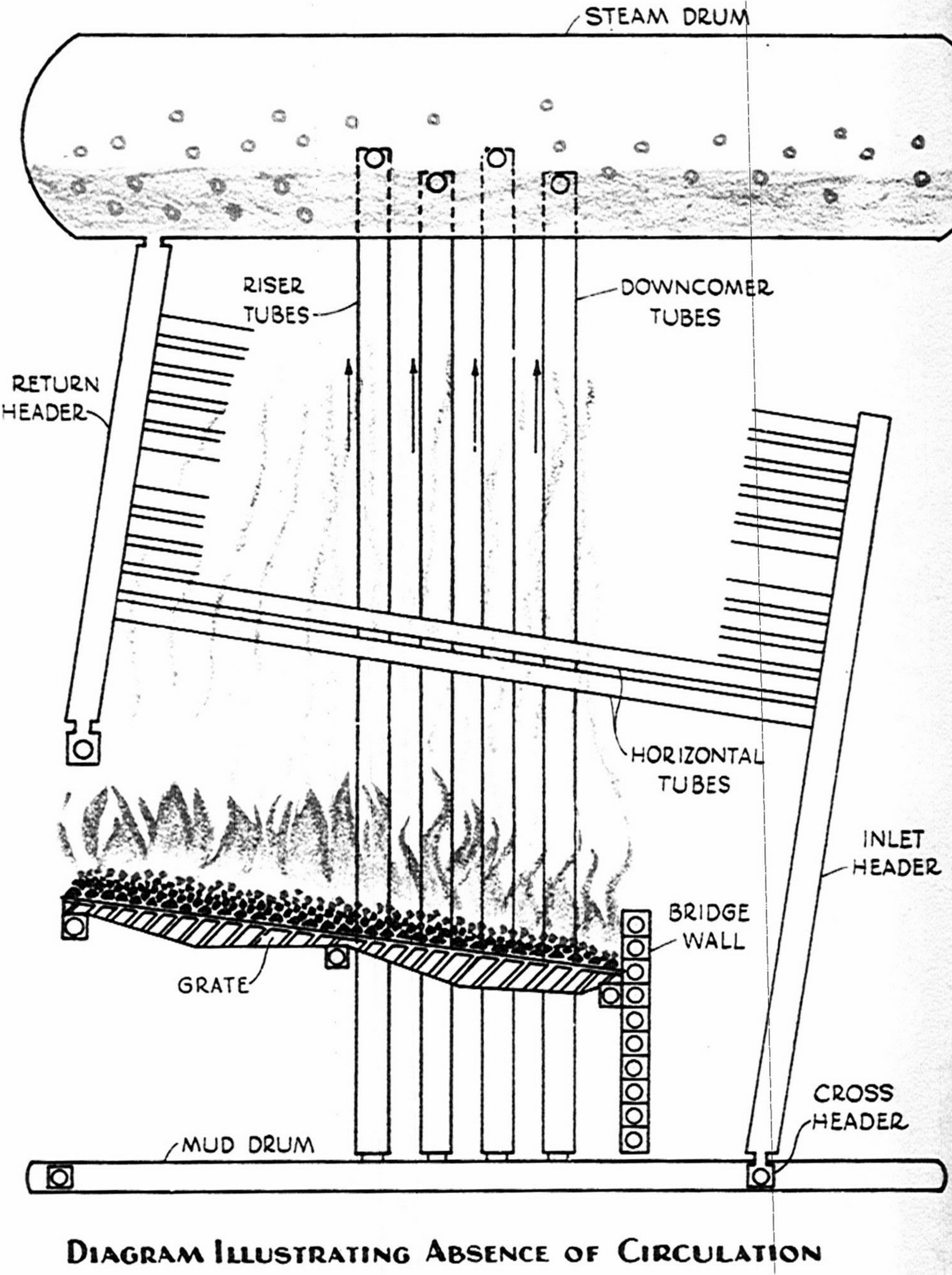

DIAGRAM ILLUSTRATING ABSENCE OF CIRCULATION THROUGH HORIZONTAL AND VERTICAL TUBES OF GRIFFITHS BOILER

GRIFFITHS PATENT Nº 743,271

the manner disclosed by Junkers and cover them with asbestos or similar insulating material if desired.

The decision of the examiner is affirmed.

WM. A. KINNAN,
First Assistant Commissioner,

W. L. THURBER,
Examiner-in-Chief,

H. EDINBURG,
Examiner-in-Chief,
Board of Appeals.

August 5, 1930.

(Here follow Plaintiff's exhibits, side folios 179-210.)

Endorsed on cover: District of Columbia Supreme Court. No. 6278. Metropolitan Engineering Company, Appellant, vs. Conway P. Coe, Commissioner of Patents. United States Court of Appeals for the District of Columbia. Filed Aug. 4, 1934. Henry W. Hodges, Clerk.

UNITED STATES
COURT OF APPEALS FOR THE
DISTRICT OF COLUMBIA

FILED NOV [illegible] 1934

Henry W. Hodges

United States Court of Appeals

for the District of Columbia

April Term, 1934

No. 6278

METROPOLITAN ENGINEERING COMPANY
Appellant

v.

CONWAY P. COE, Commissioner of Patents
Appellee

BRIEF FOR APPELLANT

MELVILLE CHURCH
D. ANTHONY USINA
C. B. DES JARDINS
Counsel for Appellant

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United States Court of Appeals

for the District of Columbia

April Term, 1934

No. 6278

METROPOLITAN ENGINEERING COMPANY,
Appellant,

vs.

CONWAY P. COE, Commissioner of Patents,
Appellee.

BRIEF FOR APPELLANT

This is an appeal from a decree below dismissing a bill of complaint as to certain patent claims which the Court was asked to authorize. The Court held the plaintiff entitled to a certain claim, 24; but dismissed the bill as to the remaining claims, 19, 21, 22, 23, 25, 26 and 27.

The findings and conclusions on which the decree was based are on page 9 of the record.

The plaintiff brought this action in order that it might present extrinsic evidence bearing upon the issue of patentability. Such evidence has been presented and not only shows that the invention has actually advanced the art very considerably, and been recognized by those skilled in the art as a substantial advance, but also makes clear the fact that the Griffiths patent, upon which the Patent Office principally relies, discloses a worthless and inoperative structure which did not, and could not, teach the art how to attain the very valuable advantages which have resulted from the use of the Murray invention.

In the Patent Office, it is usually impossible to submit convincing evidence of an actual advance in the art due to the invention in question. Frequently, the application is filed before there has been sufficient actual experience with the invention to know whether it has really advanced the art. The tendency is, therefore, for the Patent Office to consider this as an academic question and the Examiner, from the various papers before him, reaches some conclusion as to whether the invention is likely to advance the art. He compares the disclosure of the application with the prior patents and endeavors to allow claims commensurate with what he considers to be the applicant's contribution to the art. However, this is almost always a mere comparison of pieces of paper, without the benefit of knowledge of the actual effect of the invention upon the art.

In this suit under Section 4915, which the courts have held to be in the nature of a new trial, we have the opportunity of presenting evidence showing the real advance in the art due to the invention, and this evidence should be given a great deal of weight in determining the right of applicant to a patent.

In order to understand the claims refused it is necessary to first describe the invention.

The Invention

The invention is an improvement in boiler units. There are many varieties of boilers according to their fields of use and a very wide range of sizes. There are stationary boilers, locomotive boilers and marine boilers, each strikingly differentiated from the others. There are fire-tube boilers, in which a stationary body of water is carried in a tank or drum and the fire is circulated through tubes passing through the body of water; and water-tube boilers with the reverse arrangement, the water being circulated through tubes around the outside of which is the fire.

(There are also water heaters which on paper look something like boilers, but which are designed and adapted to deliver heated water, that is in liquid form, —not to convert it into vapor).

The invention of appellant, Murray, is for a furnace wall for the stationary water tube type of boilers of the size used in power plants where it is economically necessary to generate large quantities of steam from given units and where flexibility to greatly increase the output for short periods or "peak loads" is very important. *We contend that the appellant has revolutionized the art of steam boiler design, in fact he has made the most startling improvement since water tube boilers were first introduced. He achieved the goal which power plant designers had striven for since the first central station was erected, namely, a boiler unit with greatly increased capacity, high efficiency with the increased capacity, reduced cost of construction, greatly reduced maintenance costs of furnaces and finally the ability to maintain the boiler unit in service for long periods of time without shutting down for furnace repairs.*

A survey of boiler design during the last ten years shows that Murray pointed the way to these accomplishments, not by imitating previous practice, but by treading a path avoided by engineers with less foresighted vision. He was a genius in his profession, probably responsible for more improvements in steam power plant design than any other single man. Some of the largest stations in the world are monuments of his work.

The invention was the outcome of certain plans made in 1921 for enlarging the plants, including the boiler capacity, of the United Electric Light and Power Company, in New York City, one of the largest in the world. Applicant was vice-president of the company, in charge of this work. The boilers then in use were of a standard water-tube type like Exhibit 15, reproduced in Appendix I to this brief. The boiler consisted of a number of slightly inclined water-tubes 1 above walls 2 of refractory brick which surrounded a combustion chamber below.

Murray's improvement, briefly stated, was in the elimination of the refractory brick walls and the substitution therefor of water tubes combined in circulation with the upper, old system of overhead tubes, with advantages referred to in detail hereinafter.

Referring now to Murray's patent application, the complete boiler and furnace is shown in Fig. 1. The overhead tubes 62 are merely the old water-tubes of the standard boiler and are connected at their higher ends to headers 23 and at their lower ends to headers 21. The upright headers 23 lead at their upper ends into headers 48 which in turn lead to headers 25 (Fig. 2). The headers 25 and 48 together take the place of the usual single round steam drum. A mixture of water and steam flows upward through the headers 23 into this upper combination of headers, whence the steam is taken off and the water returned down the vertical headers 21 at the back. The circuit for the upper bank of tubes is the same as that in the old standard boiler.

The difference appears in the combustion chamber below and in the walls surrounding it. These walls are, at the front and back, downward extensions of the tubes 23 and 21. At the sides, they are similar tubes 20, Fig. 1. The four walls enclosing the combustion chamber are thus made of water tubes in circulation with the overhead tubes. Exhibit 3-C is a diagram of the circulation, substantially identical in construction with Fig. 2 of the application and is reprinted here on Appendix II for convenience.

The walls are covered on the outside with insulation. This detail is illustrated in Figs. 3, 4 and 5 of the application drawing. The tubes are spaced apart from each other a distance a little less than their width or diameter. The spaces between them are bridged by plates 42 welded to them at the outside. A reinforcement of wire mesh 76 is set up outside of the plates and is bent in at intervals and welded to the plates. Then a coating 74 is plastered over the whole, imbedding the wire mesh and being thus anchored directly and firmly to the tubes.

Instead of the square tubes shown in the principal figures the inventor showed a modification on the second sheet of drawings, Fig. 11. Here are shown cylindrical tubes 86*a*. The spaces between them are closed by "fins" 100. Each fin is welded to its tube and overlaps the next fin but without being welded to it. Thus each unit or finned tube is capable of slight movement with respect to the adjacent fins under the expansive forces resulting from high temperatures. This style of tube with fins welded thereon is that which was actually used.

Claims Allowed.—The claims in the case at the end of its prosecution in the Patent Office are those appearing on pages 108 to 111. Only Claim 20 was allowed. This was allowed because it contained a restriction to

> "tubes being spaced apart a distance not substantially greater than their diameter, and metal extensions from said tubes united thereto with good heat conducting joints and practically closing the spaces between them but being *free to move separately.*"

In the lower Court counsel for the Commissioner conceded also claim 24 containing the same restriction. The decree allows this claim.

The Commissioner therefore has conceded patentability only where the metallic extensions between the tubes are free to move separately. This was a very important principle. But following Murray's success many water walls have been built varying in this detail and in some cases it is not easy to show that such movement takes place. For adequate protection, claims without this limitation should be allowed.

Claims Appealed.—Claim 21 was taken by the Board of Appeals as sufficiently representative of all those rejected. We may fairly take the same position here. It reads as follows:

> "21. A steam generator including in combination approximately horizontal water tubes heated by convection and a furnace having a combustion chamber below said overhead tubes, a wall of said combustion chamber being composed of substantially upright tubes connected into the circulation of the generator, said tubes being spaced apart a

> distance not substantially greater than their diameter, and metal extensions from said tubes united thereto with good heat conducting joints and practically closing the spaces between them and providing an increased area exposed to the direct radiant heat of the burning fuel and conducting such heat to the tubes, each of said extensions being limited in width as a maximum to the diameter of the tubes, the tubes and extensions constituting a substantially closed wall exposed on the inner face only to the combustion gases, the outer surface of such wall being covered with a sheathing of insulating material united to and supported by said walls."

The references relied on by the Board were certain patents of Griffiths, McClellon and Junkers; to which the Commissioner has added in his answer a patent of Breen.

Grounds of Rejection.—The District Court's findings refer only to Griffiths, McClellon and Junkers.

Errors

Besides the errors assigned in general terms, appellant urges in paragraphs 4 and 5 errors of the Court in its reading of the prior patents.

Appellant also in assignments of error 6 to 15 criticizes the failure of the Court to find certain facts which were brought out at the trial. These were, briefly:

(6, 7) the structure of the Murray application and claims;

(8) that the practice prior to this invention was to construct the combustion chamber walls of refractory

brick which required excessive maintenance cost and kept the steam output of the boiler below 250 per cent. of its rated capacity;

(9) that the Murray application was based on the conception of a structure which would avoid such cost and remove such limitation on the steam output;

(10) that this conception was not obvious but was contrary to the opinions of skilled engineers;

(11) that the Murray invention as outlined in his sketches and disclosed in his present application was embodied in boilers Nos. 51, 52 and 53 at Hell Gate Station in New York erected by Mr. Murray in 1923 and 1924;

(12) that the invention was a great success, cut the maintenance cost from $10,000 per furnace per year to $100 or less in later installations and increased their steam output to about 520 per cent. of their rated capacity;

(13) that these boilers attracted great attention and were described as an advance in the art, credited to Thomas E. Murray, in trade journals throughout the world;

(14) that soon after this success Mr. Murray granted an exclusive license to construct boilers having furnace walls embodying his invention, under which he received royalties amounting to $350,000 to the end of 1929, the installations under this license having had a total rated capacity of 600,000 horse power; and

(15) that the Murray invention has rendered obsolete the refractory wall boiler furnaces which constituted the most approved practice before his invention.

The evidence also shows that the Griffiths patent describes a boiler which is wholly inoperative. The failure of the Court to so find is assigned as error in paragraphs 16 and 17.

Actual Practice and Murray's Advance

We will consider first the actual practice in the art and Murray's developments. We can then make a more intelligent comparison with the prior patents. For this purpose we have attached sketches,—

Appendix I, Comparsion Between Old Standard Furnace Wall and Murray Improvement, and

Appendix II, Comparison Between Griffiths and Murray Circulating Systems.

1. Prior Practice.—The first point is that in prior practice the boiler furnace was always enclosed directly in refractory brickwork or the like. This cannot be fairly questioned.

Applicant's specification (p. 105) compared his invention with previous boilers using furnace "walls of masonry or brickwork as heretofore used for stationary boilers." (The statement was restricted to stationary boilers because it had been common to make locomotive boiler casings of steel, which was never thought as good as brickwork but was a structural necessity for locomotives, something to be put up with as the only material tough enough for the purpose.) There was no challenge of this statement by the Examiner.

This statement of the universal practice of fire brick furnace walls is borne out also by Exhibit 11 offered on page 51, being a book on steam generation, published in 1923, (the year that Murray's first boiler was built) by Babcock and Wilcox, who were then the leading boiler manufacturers in the world. Every boiler illustrated in this book has its furnace walls made of fire brick. No other kind of wall is shown in that book. It represents the highest practical development at that time.

If further evidence were needed it is found abundantly in the testimony of Lawrence, commencing page 25. He first describes the old boilers of the Hell Gate Station, shown on Exhibits 1 and 2. These were of fire brick, 18 to 22 inches thick.

> "This practice * * * was the standard practice in every power plant of any size that I knew of anywhere in the world" (p. 26).

The witness was in a position to know. He was a mechanical engineer, entered the employ of the New York Edison Company in 1909, became assistant mechanical engineer of the company in 1913, continued his work there until 1920 when he became vice-president and engineering manager of Thomas E. Murray, Inc. This company was incorporated primarily to design the Hell Gate Station. He supervised power plant work in various places costing a total of more than a hundred million dollars (p. 20). From 1910 on it became his duty to collect information on power plants including the reading of technical magazines from all over the world (p. 21). He knew his subject.

Not only does he say that every power plant of any size had fire brick furnace walls but also (p. 28) that the plants under construction in 1923 "all had fire brick or refractory furnaces." Engineers had no precedent for the Murray water wall.

2. Murray's Advance.—Compared with the approved prior practice, Murray's invention saved practically all the maintenance cost on furnace walls and effected further large savings by increasing the capacity, besides removing the limitation which the old walls had imposed on the output of steam.

The saving in expense was the prime motive of the inventor. A second, but probably more valuable function of the improvement was in the increased capacity.

Lawrence testified (p. 27) that the maintenance cost on the old Hell Gate boilers was about $10,000 per year per boiler, and that they could not be operated continuously at more than 200 per cent. of rating or, for short periods, 250 per cent. The "rating" of a boiler is the standard quantity of steam which it should deliver, based on the number of square feet of heating surface. All boilers can be forced by burning more than the intended normal quantity of fuel per hour in them. This flexibility, or capacity for increased output over normal, is valuable particularly in boilers for power plants. The "load," or demand for electricity, varies widely through the day and night making up each twenty-four hours. The boilers are better to the extent to which they can comply with this variation in demand.

Where the old standard boilers were capable of doubling the output, or running at 200 per cent. of rating, the Murray boilers increased this limit to at least 500 per cent. by actual trial.

The Murray wall has made possible "capacities far *in excess of anything we had ever dreamed of.* The capacity of steam boilers has been increased from two to five times * * *" (p. 39).

This great flexibility, or capability of increased output, was beyond even the expectations of the inventor. In the first installation the accessory apparatus was not sufficiently large to take advantage of this possibility. The fans which supply air for combustion failed before reaching the volume which the boiler could take (p. 35). In subsequent installations the extent of the water wall was increased, "and today in large boilers there is practically 100 per cent. water wall construction around the furnace" (pp. 38, 39). The accessories of course have been enlarged accordingly.

The saving in floor space depends of course on the cost of the space. Around New York City it is very high. But wherever located there is a large saving in multiplying by five the capacity for a given floor space (p. 39).

There is economy also in building one large-capacity boiler instead of five small ones. With the Murray invention a single boiler has been built with an expected capacity of a million pounds of steam per hour and has been pushed for a short time to a million and a half. *Such a boiler alone would produce enough steam for all the generators which supply the city of Washington, D. C.* (p. 39).

Besides the money saving in space and initial cost there is a large saving in maintenance cost. The maintenance cost for some of the old refractory wall boilers was $10,000 a year (p. 40) and an "outage" or time out of service for repairs amounting to three or four weeks each year (p. 28). With the Murray boilers there is no outage and not more than $100 a year maintenance cost (p. 40).

The front and rear walls of the combustion chamber of the Hell Gate installation were built of refractory material, but the two side walls were of the construction described in the Murray application. Thus, the Murray invention was not applied to its full extent in these boilers, but, nevertheless, it was found that the furnace walls were no longer a factor limiting the steam output of the boiler. This was true of all four walls, although only the side walls were of the Murray construction. The presence of the side walls, however, absorbed so much reradiated heat from the front and rear walls as to keep those walls cooled below the danger point. In fact, experience with Boiler No. 51 showed that it was possible to burn fuel in that furnace just as rapidly as you could get the fuel into the furnace and take the gases away, and without any perceptible harm to the furnace walls. The furnace walls were no longer a limiting factor holding down the steam output of the boiler.

On page 414 of "The Electrical Times" for October 9, 1924, (Pl. Ex. No. 10), is a tabulation of the results of tests on boiler No. 51. Mr. Lawrence testified that these results are correctly stated in this tabulation. It appears that this boiler had 15,900 square feet of heating surface. If operated at its rated capacity, therefore, it would turn 55,650 lbs. of water per hour into steam. If forced to 250% of its rated capacity, which was the maximum considered possible with the old refractory walls, it would have converted into steam 139,125 lbs. of water per hour. The test of February 15, 1924, however, contained in column 4 of the tabulation, shows that it was possible to force the boiler at such a rate that it converted 290,000 lbs. of water per hour into steam. Thus, the maximum steam output of the boiler was more than doubled because of the use of the Murray invention. It may not be necessary, at all times, to run the boilers at maximum output, but the fact that it is possible, without harm, to force the boiler so far beyond its rated capacity is of the greatest importance, because it enables these boilers to respond to the demand of peak loads. In other words, when the demand for electric current rises suddenly to a maximum, it can be satisfied by forcing the boiler, and it is not necessary to have additional boilers called into service to take care of this peak demand.

3. Invention vs. Skill.—That Murray's conception was not an obvious one is apparent on its face. It is indeed a striking proposal to substitute for the most refractory fire brick a much less refractory material like hollow steel, realizing that water would be circulated through it so rapidly (about 30 feet per second) in the steam generating system as to prevent its melting.

We have also positive evidence that the idea was not obvious. The witness, Mr. Lawrence, said (p. 29) that he "was very much against" the idea; that it was "directly contrary to what engineers had been advocating for a number of years"; that they thought the heat would burn holes in the tubes. He also was afraid that the temperature of the furnace would be lowered and the efficiency of the boiler diminished. "Everyone" advocated incandescent (refractory) walls. "Mr. Murray took the opposite position to what other engineers had taken." Lawrence was mindful of the fact that the trend in boiler design, for some years prior to this date, had been toward getting the approximately horizontal steam generating tubes further away from the fire, because of the difficulties that had been encountered due to these tubes burning out on account of hot spots. It seemed to him, therefore, that it would be out of the question to put water tubes as close to the fire as they are in the side walls of the Murray furnace. Moreover, Mr. Lawrence felt that, if these side wall tubes could stand up, the water circulating through them would cool down the combustion chamber so much that it would interfere with the combustion of the fuel. Mr. Lawrence was, and is, a highly competent engineer, skilled in the art of boiler construction, but the idea which Mr. Murray submitted was not an obvious one to him. It did not seem to Lawrence the natural thing to do. On the contrary, it seemed to be an unnatural thing and a step in the wrong direction. This is strong evidence that what Mr. Murray proposed to do and did amounted to invention.

On pages 32 and 33 he tells of Mr. Murray's discussion with the many engineers of the New York Edison and allied companies, and that "every one of them attempted to discourage him." On a trip to a Pittsburgh steel plant he was dramatically convinced of the soundness of his ideas by seeing a water-cooled pipe exposed to even higher temperatures than are encountered in boiler furnaces.

After these first studies, as embodied in the drawings (Pl. Ex. Nos. 3a to 3g, inclusive), Mr. Murray had his engineers and draftsmen draw up a layout for certain new boilers to be installed in the Hell Gate Station, embodying the principles outlined in these preliminary studies. This layout was then submitted by Mr. Murray to a committee of competent engineers of high standing, who were associated with the power company operating the Hell Gate Station (p. 33). These engineers, after studying the layout, turned it down for the reasons that Mr. Lawrence had advanced; that is, that the tubes would not stand up so close to the fire and, further, that they would cool down the combustion chamber to such an extent as to interfere with combustion. Again, we find, in this incident, strong evidence of invention. These skilled engineers did not consider that what Mr. Murray proposed was the natural and obvious thing to do to overcome the difficulties with the old refractory walls. *It seemed to them to be the wrong thing to do—the unnatural thing. It was not what these men, skilled in the art, would adopt.*

This situation is characteristic of the highest type of invention which is a combination of imagination, faith and persistence against opposition.

4. Identity with Hell Gate Boilers.—The very Murray invention that is presented in the claims here is the one which was embodied in the Hell Gate Station boilers 51, 52 and 53. A working drawing of these boilers is Plaintiffs' Exhibit 4. The horizontal or slightly inclined steam generating tubes are indicated at (C). Below these is the combustion chamber. The far side wall shows in the cut. It is entitled "Vertical Tubes of Water Wall." Lawrence testified (p. 51) that the insulation on the outside of the wall was tied in to that which is shown in the photograph, and was tied in "so that the entire assemblage was held together." Lawrence testified further (p. 58) that in the Hell Gate boilers the design of tubes used was the finned tubes of Fig. 11 of this patent application. The drawings which Mr. Murray submitted to his engineers (p. 33) are Exhibits 3-A to 3-G, inclusive, and these disclosed the idea "substantially as it was used in the installation which became boilers 51, 52 and 53 at the Hell Gate Station." Let us review these drawings, described by the witness, pages 30 to 33.

Exhibit 1 is a study of one of the old boilers, for comparison with the new. Exhibit 3-A shows how it was to be changed in order to surround the combustion chamber with water walls. Exhibit 3-B is a simplification of 3-A and is practically identical with Fig. 1 of the application drawings. Exhibit 3-C is a very interesting diagram illustrating the combining of the two circuits, that of the overhead tubes with that of the water wall tubes.

The remaining figures illustrate details. Exhibit 3-E illustrates finned tubes with outside reinforcement welded to the fins and designed to carry the refractory coating.

Let us compare the construction thus disclosed with the very specific claim 21 which we have taken as representative.

a. The apparatus of the aforesaid exhibits, 3-~~B~~A to 3-G, 4, 5 and 12-A to 12-C is certainly the "Steam generator" of the claim.

b. The approximately horizontal water tubes are indicated at (C) in Exhibit 4 and are heated by convection from the gases of combustion passing between them.

c. The open space below said tubes is the "combustion chamber."

d. The "wall of the combustion chamber" is shown at the far side and is "composed of upright tubes connected into the circulation."

e. That the tubes are "spaced apart a distance not greater than their diameter" and have metal extensions united to them, closing the spaces between them and providing an increased area as claimed, is shown in the photograph Exhibit 5, but not very clearly because of poor reproduction of this exhibit.

f. Each of the extensions is "limited in width as a maximum to the diameter of the tubes," being considerably less in fact.

g. The tubes and extensions constitute "a substantially closed wall exposed on its inner face only to the combustion gases," as shown in Exhibit 4, "the outer surface being covered with a sheathing of insulating material united to and supported by the wall," as testified to by Mr. Lawrence in connection with Exhibit 5.

The Hell Gate boilers 51, 52 and 53 clearly embody the claimed invention. The success and fame that attached to that installation rest principally on appellant's invention here claimed.

We have referred particularly to the Hell Gate boilers because they were the first and were the foundation on which the fame of the invention was first gained. These were immediately followed by other boilers for allied companies, and the testimony refers particularly to the East River installation, photographs of which are Exhibits 12-A, 12-B and 12-C.

Exhibit 12-A shows an outside view of the finned tubes, together with rods fastened to them and intended to be embedded in plastic insulation. The intermediate stage of plastering is shown in Exhibit 12-B, and the final stage in Exhibit 12-C. This is another method of tying together the assemblage of tubes and insulation.

5. Public Recognition.—The economy and the greatly increased output of these boilers resulted, Lawrence testified (p. 38), in "more publicity, I think, than any other boiler ever built anywhere in the world." The results of the tests were published all over the world. Papers giving accounts of it were presented in various countries. Technical magazines gave it considerable prominence. Engineers from the other side came to this country "just to see these boilers." A prominent French engineer asked Mr. Murray to cable him as soon as the boiler was in operation so that he could come over and see it.

Lawrence repeated this story (p. 46) and offered Exhibit 10, a book of photostats of what the witness called "a few" of the technical press clippings which he had collected. He referred briefly to the several articles on pages 47 to 50. Most of them refer to the "Murray" water-cooled furnace wall. Some of them cover the tests in detail. They are all substantial publications. Many of the articles are written by well known engineers: David Brownlie, H. D. Savage, Mr. Spencer and Mr. Broido and others.

The principal reference is to the Hell Gate station. Others referred to as including the Murray water wall are a station at St. Louis, at Kips Bay, New York, and at East River, New York.

The dates run through 1925, 1926 and 1927.

The Queensland, Australia, Journal article was entitled "The Murray Water-Cooled Combustion Chamber Wall. A Remarkable Invention."

It is very apparent that the invention acquired great fame among engineers as soon as it went into use.

6. Profits.—Probably the best evidence of success is furnished by the actual sale of the invention. Mr. Murray sold his exclusive rights and within a few years collected royalties of $350,000. Since that time the returns have been smaller because the building of power plants and large boilers almost ceased. But practically all such boilers built have embodied this invention.

Lawrence testified about this license and introduced it as Exhibit 7, page 41.

The exhibit, dated 1924, printed commencing page 81, provides that Murray and associates are owners of certain patents and pending applications listed in "Exhibit A," grants an exclusive license throughout the world under said patents and applications insofar as they apply to "stationary power plants" and related devices. Royalties are provided of 50 cents per horsepower on boiler installations, with a minimum of 25,000 dollars the first year, 50,000 dollars each for the second and third years, and 75,000 dollars for each year thereafter.

The list of patents, "Exhibit A," commences on page 85 and runs through four pages of patents relating chiefly to electric welding, but includes a few patents relating to boiler tubes. It concludes on page 90 with a list of pending applications, fifteen in all, of which five are for boilers. One is application No. 642,427, which is the present application.

The modifying agreement, page 90, signed in 1926, modified the scale of royalties.

On page 93 commences a list of boilers made under this license and reported by the licensee up to the time of its receivership in the end of 1929. In these five years there were reported 203 installations each including from 1 up to 10 boilers. The years 1930 to 1933 were depression years and the Company was in receivership, but it reported 25 installations. Also Murray water walls were installed in old furnaces to a total of 37 (p. 98).

The widespread use is indicated by the list (p. 99) of countries in which the invention was installed,—14 countries besides the United States. And this is followed by a list of the public utilities and railways in the United States, 21 in number, which are most prominent as to size. Also list of 21 prominent industrial companies. Most of their names will be recognized as those of large manufacturers.

A recapitulation follows on page 100. It shows 228 installations. Some of them included more than one boiler, *the total being 439 boilers* and the capacity being 672,162 horsepower; approximately 1,500 horsepower average size. The figures given were the rated or theoretical horsepower according to old methods of calculation rendered practically obsolete by the Murray invention. "The actual horsepower developed was probably three or four times that" (p. 45).

The royalty paid under the contract was 379,786 dollars, with 150,000 to 200,000 dollars still due.

Most of the patents listed in the license were for electric welding processes which the parties might have used, but did not, in making the finned tubes. The principal factor in determining if a royalty was due was if the installations incorporated "the water wall development which had been made for the Hell Gate boilers Nos. 51, 52 and 53, or any improvement made thereafter"; which means the present application, which was the first and basic one, or any of the improvements thereon which followed.

In vulgar parlance, "money talks." *It is not conceivable that about half a million dollars would have been paid for the use of anything short of a new and striking improvement.*

7. Immediate Disappearance of Old Refractory Wall Structure.—The old refractory wall boiler furnaces were rendered obsolete by the Murray invention. There is the list above referred to of 37 old installations made over to incorporate the water wall. This is an expensive operation. It would not have been performed except with an assurance of much improved results.

Lawrence testified to the scrapping of the old idea of refractory walls immediately upon the appearance of the Murray water wall (pp. 38-39). The Hell Gate boilers with water walls at the sides only was such an advance in the art of building boiler furnaces that steps were taken immediately to further carry out the idea of water walls; and today in large boilers there is practically one hundred per cent. water wall construction around the furnace. It has entirely revolutionized the building of boiler furnaces.

Again (pp. 50 and 51) referring to the 1923 publication of Babcock and Wilcox (Exhibit 11), and referring to the furnace walls of fire brick he said:

> "The furnace wall constructions as illustrated in this book have become obsolete today for the modern plant, except in the case of small boilers in heating a house or building, or small power boilers. But for power-station boilers that design has become absolutely obsolete.
>
> "*What has rendered that design obsolete is the development of the Murray water wall*; that is, the construction used in boilers numbers 51, 52 and 53 at Hell Gate station."

(This refractory brick wall, exposed to the fire, is very different from the insulating material which is coated on the outside of the Murray wall. The insulating material is merely to conserve the heat within the furnace. There are many insulating materials which are not refractory, that is, resistant under direct exposure to the fire. Murray's coating of insulating material has no structural function.)

The reason for the quick discarding of the refractory wall is explained in the testimony, particularly pages 24 to 27. It is clear that engineers knew the defect involved in the use of the refractory furnace walls, but *continued to use it because they knew nothing better.* Up to 1923 it was thought necessary to have an incandescent wall in the furnace in order to maintain proper combustion. It was also found necessary to locate the old steam generating tubes high above the fire to avoid their becoming overheated in spots and so as to burn the fuel completely (for economy's sake). In power plants the cost is so high that you try to get the maximum output of steam from the boilers, which means burning more coal per hour per boiler, which means increasing the temperature of the fire very materially.

Now the effect of increasing the temperature in the combustion chamber is to reduce the strength of the refractory wall exposed to it. You may reach a point where the fire brick no longer has any strength, so that "the walls may collapse due to their own weight. That occurred quite frequently" (p. 27).

One very apparent objection to the refractory walls was the annual cost of maintenance and outage of the boiler for repairs, referred to above.

An even more serious defect was *the limitation which the refractory walls imposed on the temperature and* *thus on the quantity of coal that could be used and the output of steam per hour.* It is a strange comment on the difference between engineering knowledge and invention that Mr. Murray's engineers thought that the combustion within the furnace might be retarded by the proposed water walls (p. 34). The point is summed up by Mr. Lawrence (pp. 39 and 40) as follows:

> "This water wall construction makes possible this tremendous increase in boiler capacity in the following ways.
>
> "The use of this water wall construction around the combustion chamber enables the burning of greatly increased quantities of coal in the combustion chamber.
>
> "The limitation before this development was the refractory material forming the wall. The refractory materials could not stand the high temperature of the burning gases. With the water wall it is possible to greatly increase the amount of coal which can be burned in the same size furnace.
>
> "In other words, the furnace before was the limiting factor. Today the furnace is not the limiting factor. As far as I know, nobody has ever pushed a water wall furnace to the point where it could not burn more coal.
>
> "The boiler today is just the same as it was before the development of Mr. Murray's wall; that is, the boiler proper, the horizontal tubes. The boiler always had the capacity before, but it never had the opportunity to do the work because the heat could not be gotten to it; that is, the heat could not be liberated into the boiler furnace."

This element of the new combination, the circulating system of the water walls, not only serves to keep the walls and temperatures such that they will not deteriorate, but also serves as a valuable addition to the steam generating equipment of the boiler.

No wonder the old refractory walls were immediately put out of business.

Prior Patents

If we had only to consider a comparison of the old with the new, as they were met with in practice, there is no doubt that patentability would be found in the new Murray boiler.

But in the "limbo of forgotten things" the Commissioner has found certain patents which in his judgment stand in the way of patentability here. *A very strong showing should be required in these prior patents to justify a refusal in view of the practical aspects of the case.*

The Commissioner had to take these prior patents at their face value. He has neither money nor time for taking evidence nor for testing the practical value, the sufficiency of disclosure nor the operativeness of the patents or applications pending before him.

Plaintiff has brought this action in order to submit evidence concerning the Murray invention and concerning the disclosures of the prior patents. The evidence shows two reasons for granting the claims sought. First, the Griffiths patent, which is mainly relied on, is inoperative. Second, there is nothing in the patents cited, taken separately or together, which made obvious in 1923 the particular combination here claimed.

The three patents referred to in the findings of the District Court are Griffiths, McClellon and Junkers.

Griffiths Patent.—The first criticism of this patent is that the boiler therein is *inoperative.* It will not have the circulation which is essential in water tube boilers.

The diagram (Pl. Ex. No. 14) illustrates graphically the principles of boiler circulation. If heat is applied to one leg only of the closed loop, as in Fig. 1, the heated column of water therein, being lighter than the cooler column, will tend to rise and allow the water in the other leg to fall. The presence of bubbles of steam in the heated leg, which rise, tends to make this column still lighter and accelerates the upward movement of the heated column of steam and water. Hence the water circulates about the closed loop in the direction of the arrows (Fig. 1). If, however, both legs of the loop be heated, as in Fig. 2, there will be no difference in weight or pressure tending to cause circulation. The steam generated by the heat will rise to the surface, as indicated by the arrows, there will be no circulation, and the water will simply be boiled away. The fundamental principle underlying water-tube boilers is that heat shall be applied at one portion only of a closed circuit, setting up a pressure differential causing the water to circulate positively and rapidly through the inclined horizontal tubes.

Let us ascertain what we can from the patent as to Griffiths' theory of circulation. He has (Fig. 5) a bank of inclined tubes of the standard type with outlet headers 23 at their upper ends through which the heated water and steam rise into a drum 21 overhead. To convey water into the lower ends of the inclined tubes, he has inlet headers 24. But here is a departure from the old standard boiler of Exhibit 15 where the water should come down these headers *from the drum.* Instead, the headers 24 take in water at their lower ends only, the water moving upward and thence into the inclined tubes. The headers 24 are supposed to take in water at their lower ends from a transverse header 35, which takes in water at both ends from drums 32. These drums 32 at the sides, are in communication with the lower ends of square water tubes 33 arranged side by side and extending up to the sides of the overhead drum (Fig. 4). At the upper ends these tubes 33 are "secured in the steam drum 21, alternately above and below the water line thereof." Fig. 5 shows a horizontal dotted line which must be the contemplated water level, between the lines of the ends of the alternate tubes.

This is the *only hint in the patent* of the method of circulation. Apparently Griffiths assumed that hot water and steam would come out of the upper row of nipples and that water alone would pass out of the lower row of nipples, down the tubes 33 and thus into the drums 32, the cross header 35 and up the headers 24; partly returning from the drums 32 upward through those side tubes 33 whose nipples are above the contemplated water line of the steam drum.

But this is impossible. These side walls cannot have comparatively cold water coming down one tube and steam and hot water going up the next one in close contact with it and exposed to the same heat. There can be no such circulation. The only effect of heating two such tubes would be to generate steam and cause it to rise equally in both of them. The side walls would act like an ordinary kettle or tank or like a fire-tube boiler in which there is no such thing as circulation through a definite line of tubing. That was Griffiths' contemplated mode of operation when his specification spoke of "increased heating surface'' and ''a large body of self-contained water separated into numerous small volumes.''

Counsel for the Commissioner undertook to find some other way of getting the water down. He invented the theory that at the rear end of the boiler the tubes 33 would be colder than at the front end and that this might induce the desired circulation. But that is not correct. Any two adjacent tubes at the rear are heated to substantially the same degree. Even the two or three tubes 33 at the extreme right are heated by the flame passing out to the uptake 27. The Commissioner's brief below states that his theory of a circulation downward by the tubes at the right is admitted, but this is not correct. What the witness said on cross examination only shows that he was trying to be entirely fair, but not that he conceded a practical circulation in the Griffiths boiler. He said (p. 76): ''I don't believe the water would descend down the rear end of this boiler when the heat is at the front end to a sufficient extent to supply the side walls. There might be a slight flow at the very ends of the boiler. But the flow would be so slight that it would not even take care of the side walls.''

Taking this with his further testimony referred to above, we must conclude that in his opinion as a practical man there is no such circulation as Commissioner's counsel have thought. And it must not be forgotten that such a circulation *is not the idea of Griffiths.*

The Commissioner's theory is quite unsound because it overlooks the fact, which was pointed out by Mr. Lawrence in his redirect examination (p. 80), that the baffle 26 would direct the flames from the fire against the tubes at the right in Fig. 5, causing a very high temperature in that portion of the boiler. Consequently, these right-hand tubes would not be substantially cooler than the tubes immediately over the fire bed. It was also suggested, by counsel for defendant, that the headers 24, because of their location, would be cooler and that, therefore, water would tend to flow downwardly in the headers 24. This ignores the fact that water must flow in the opposite direction in headers 24, because the inclination of tubes 22 requires that the water shall flow upwardly in the headers 24 and, thence, through the tubes 22 to the upper ends thereof. No one has advanced any theory by which the Griffiths construction can be made operative, or of any value whatsoever.

There is no evidence neither within nor outside of the patent to support the theory brought forward on behalf of the Commissioner. Plaintiff has adduced evidence, both expert and reasonable, to show that the Griffiths boiler was never heard of in the industry, won't work and is in fact dangerous.

Lawrence explained the contemplated circulation by reference to Exhibit 18, illustrating the principle, omitting unessentials. He criticized the described operation in his testimony commencing page 66.

Referring to the water level in the drum he pointed out that in fact, "the level in a boiler never remains constant." In a power boiler it may vary from 12 to 18 inches. Griffiths has "a theoretical water line, which in actual practice could not possibly exist."

At the top of page 68 he says that when you generate steam in the Griffiths boiler, "I believe that the flow will have a tendency to go upwards in every tube of that boiler." And further on that page, "no water, in my opinion, can come back from the steam drum. In other words, it is a boiler that could not possibly be operated."

Moreover, the Griffiths boiler includes a number of horizontal tubes such as 41, 20, 42, 43 and 40. These tubes are absolutely horizontal and connected at their ends to points of equal pressure. Therefore, there will be nothing to cause a flow in these tubes in one direction or the other and, when heat is applied, the water in such tubes will merely be boiled away and the tubes will burn out because there is nothing to cause a circulation through them.

Lawrence made inquiries (p. 70) and, so far as he could learn, the boiler has never been built. He discussed the construction with other engineers of considerable standing, who confirmed his view that the Griffiths boiler was not operative.

In conclusion on this Griffiths boiler (p. 71) he says:

> "This patent teaches the art absolutely nothing. I would say that it leads the art in the wrong direction.
>
> "I don't think that this boiler would be passed by any boiler commission in the entire United States. It is absolutely unsafe."

On cross examination (p. 76) he pointed out the fundamental distinction of the Murray scheme, in the matter of circulation, from that of Griffiths. See Appendix II. Murray uses the vertical headers 21 at the back to bring water from the steam drum directly to the lower ends of the inclined tubes 62 (the old standard circulation) and carries the water further down the same headers 21 and upward through *all* the side tubes 20.

If Griffiths had arranged to bring water down from the drum through the headers 24 he could probably have maintained the desired circulation. This he did not do.

(The lines of square tubes 41 are merely water-cooled baffle walls designed to direct the flame in a zigzag path through the bank of tubes.)

An important feature of Murray's wall is that it is "connected into the circulation of the generator." As stated in the testimony of Mr. Lawrence, this is of the utmost importance. The steam generator must have a circulation, which will cause water to flow positively through the horizontal convection tubes. Likewise, it is even more important that the water shall be caused to flow rapidly and positively through the tubes composing the walls of the combustion chamber. These tubes are exposed directly to the radiant heat from the fuel bed and would not last any time at all, if it were not for the fact that the water is caused to flow positively and quickly through them. This is accomplished by connecting these tubes into the circulation of the generator. The Griffiths boiler does not have any circulation and, consequently, the tubes 33 at the sides of the fire-box are not connected into the circulation of the generator. It lacks any means for causing water to circulate positively and rapidly through either the side tubes or the horizontal inclined convection tubes. This lack of circulation is the inherent defect, which renders the Griffiths boiler worthless and inoperative. The Griffiths boiler fails, because it lacks the very thing specified in these claims. Lacking this essential feature, the Griffiths patent cannot be considered, in any sense, an anticipation of the claims. Moreover, there is no evidence that it would be possible, using the ordinary skill of the worker in this art, to so modify and change the Griffiths construction as to give it the circulation which it must have, if it is to be operative.

The metal extensions into the spaces between the tubes of the Murray boiler wall are also particularly important. They provide each tube with a surface exposed to radiant heat, which surface is much greater than that exposed by plain tubes or by the Griffiths tubes. Each of the Murray tubes contains the same volume of water as an ordinary boiler tube but, with the aid of the extensions, presents a greater heating surface. Thus it applies a greater volume of heat to the water in the tubes, which induces a more rapid circulation of the water.

Griffiths does not show anything of this sort. This is a true combination of elements, which cooperate to produce a new and useful result, that is to say, a boiler having a combustion chamber wall such that a greatly increased output of steam may be obtained from the boiler, because the furnace walls can withstand the excessive temperatures produced when the fire is forced in order to give the increased steam output.

We may close the discussion of operability with the last paragraphs (p. 81) of the Lawrence testimony:

> "There is absolutely nothing in the Griffiths patent that indicates that he intended to have the water come down at the right-hand side of the tubes 33 of this group and to go up in the left-hand tubes of that group. It is very clear from reading the Griffiths patent that what he intended was that the water should go down through one tube and up through the next tube to it; that is, go down through the tube which has its mouth below the water level, and come up through the next tube, which delivers above the water level. That is very clear from lines 75 and 76—'alternately above and below the water line thereof.'

> "*Recross examination*:
>
> "Griffiths doesn't specifically state that the water is to go down the submerged tube and steam come out of the exposed tube. But it is very clear to an engineer reading this patent that that was the way Griffiths intended his boiler should work."

Furthermore, assuming operativeness of the Griffiths boiler, it is not an anticipation of Murray to the extent relied on by the Commissioner.

Taking the typical claim, 21, by the elements successively stated,—

1. The "horizontal water tubes" are found in Griffiths, with the combustion chamber below.

2. The wall composed of "upright tubes connected into the circulation" is found in Griffiths on the unsound assumption that his side walls have a circulation.

3. The Griffiths tubes are not "spaced apart."

4. They have no metal extensions.

5. The outer surface of the Griffiths wall is not covered with insulating material "united to and supported by" the water walls. The wall of Griffiths is the old casing consisting of metal sides 12 (Fig. 3), back 13 and front 14 (Fig. 5) "secured together on their outer surfaces and provided upon their inner surfaces with a lining" of fireproof material. They rest on the floor. They are not "supported by the walls," as required by Claim 21. It is these distinctive features, the spacing of the tubes, the metal extensions between them and the plastic insulation anchored to the outside of them that characterized the startlingly successful Hell Gate

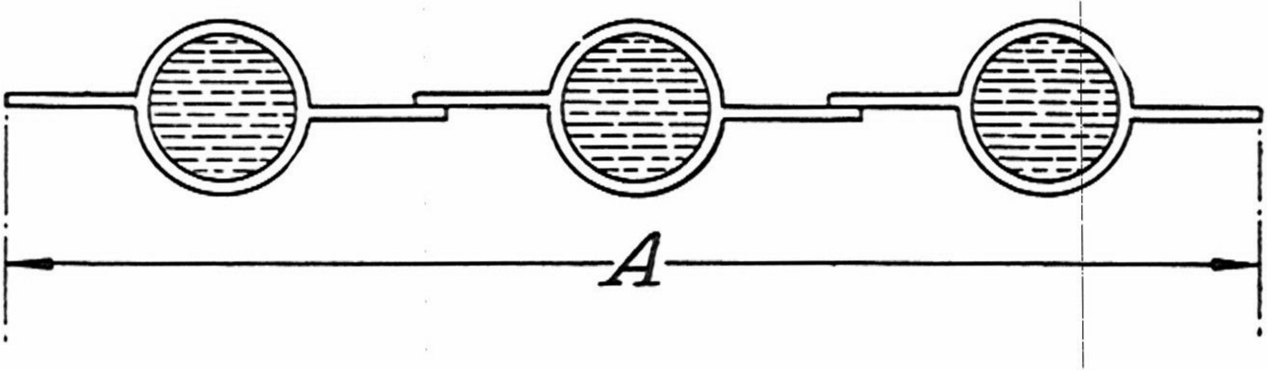
boilers. When that feat was accomplished there was no power plant engineer who knew how to do it. They did not know that furnace water walls could be successfully substituted for the old firebrick walls. Credit for great originality must go to appellant for conceiving a workable substitute.

The presumption of the law, that a patentee is familiar with everything previously patented, does violence to our reason. But assuming that Murray had heard of such a style of walls, in other connections, it is again absurd to assume that such knowledge pointed an obvious way to the perfection of his water wall idea. The same knowledge was in the minds of or available to his fellow engineers. Reason teaches us Lawrence is right in saying that the industry would have adopted readily any obvious solution of the difficulties presented by the refractory walls around the furnaces of water tube boilers.

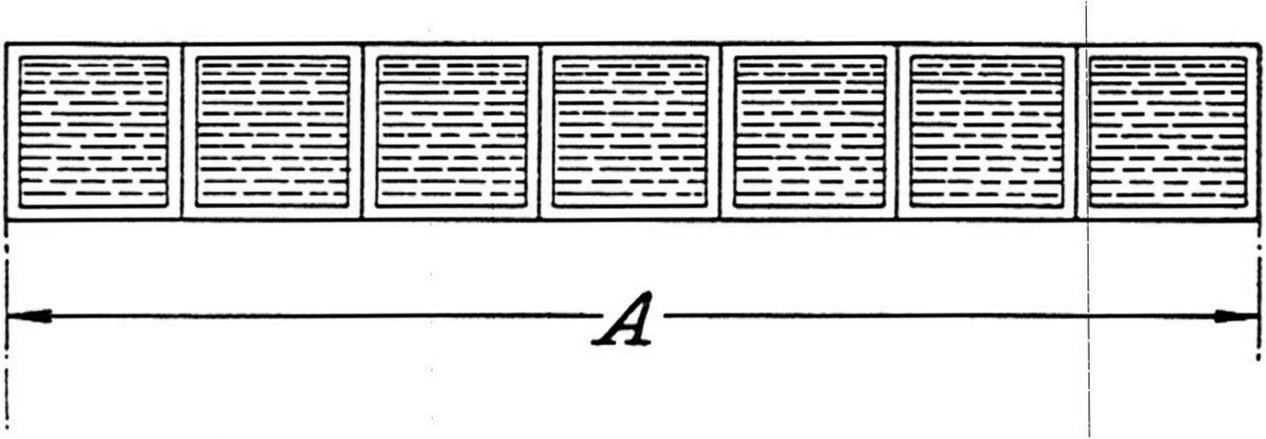
Specific Claims for Spaced Tubes.—Certain claims, Nos. 19, 21 (quoted above), 23 and 25, refer particularly to the spacing of the tubes and the provision of metal fillers between them. This construction has two distinct advantages in the combination claimed. First, it provides a greater heating surface per unit of water so that the water is heated faster and steam is generated faster; which accounts for the extraordinary increase in capacity which has been developed. Second, the Murray wall exposes the flame to the cooling effect of a smaller quantity of water.

In the sketch below are shown in plan portions of a Murray wall according to Fig. 11 of his drawings and a section of the Griffiths wall. The heating surface is proportional to the straight line A which marks the width. The sections illustrated, therefore, are both of the same heating surface.

MURRAY (FIG. 11)



GRIFFITHS



Assuming the tubes to be of the same width, Murray has less than half as much water volume for each unit of width. This naturally means a very much higher rate of heating, a very much greater velocity of circulation and a very much greater capacity for generation of steam per hour.

In the second place, the diagram shows that Griffiths presents a practically continuous body of water to the flame, two or more times the volume of water presented by the Murray wall. The Griffiths wall is suspectible to the criticism of the engineers who first objected to Mr.

Murray's scheme, that the water might cool the flame to such an extent as to prevent complete combustion within the chamber. Murray's design is much less susceptible to this criticism. In practice it proved itself entirely free of this defect.

The spacing of the tubes and the provision of fins or the like between them are not mere verbal distinctions. They are differences which are fraught with substantial changes in operation.

Not every old water wall would have given rise to such a great advance in the art. It is only the particular Murray wall covered in these claims with spaced tubes and fillers as described that has done the trick. Practically all later furnaces in this industry have included water walls of this particular character.

The Patent Office does not rely upon the other patents set up in the answer, as showing the combination covered by the claims in suit. If the Griffiths patent is eliminated as a reference, because of its worthless and inoperative character, or because it does not disclose the basic combination covered by the claims, the Patent Office rejection must fall. However, it may be well to consider briefly the three subsidiary patents mentioned by the defendant.

McClellon Patent.—This is the patent which the Commissioner superimposes in part on that of Griffiths in order to build up an anticipation. We say first that it does not disclose the elements of the claim for which it is cited; and, second, that if it did disclose the same elements, the disclosure is not such as to suggest their substitution for the Griffiths walls.

1. The Board of Appeals tried to find the detail of applicant's wall in the references but admitted (p. 120) that McClellon's insulating material "is held in place by an outer covering [like the casing 12 of Griffiths] rather than being attached directly to the tubular wall [as required by appellant's claim]." For this item the Board resorts to a third source, taking judicial knowledge of the plastering of insulating material directly upon furnace walls (of unidentified design). McCellon is relied on only for the construction referred to on page 3, line 50, of his specification, as follows:

> "The spaces between the side walls of the tubes may be closed by fillers 89 welded thereto, thereby forming a side wall which, in effect, is an integral whole."

This is the statement of the Commissioners' counsel (p. 78). He refers also to the covering of the side walls by asbestos, but does not assert that this is "united to and supported by" the water walls, as required by Claim 21.

It is noticeable also that there was no cross examination of the witness on this McClellon patent. Let us see what the witness said about it on direct examination, commencing page 71. In the first place it is in an art very remote from that of the Murray boilers. Instead of a stationary water tube boiler, as is Murray's, it is a locomotive fire-tube boiler. This is practically "a tank" through which a number of tubes pass. It is "just the reverse" of a water-tube boiler. The problems encountered in water tube boilers (the cost of maintenance of fire brick walls and limitation on the quantity of coal that can be burned per hour) are not encountered in fire-tube boilers.

There is no reason in the world why a power plant engineer designing a water tube boiler should look into the art of locomotive fire-tube boilers for helpful hints.

What McClellon calls "the barrel" in Fig. 1 is a cylindrical tank full of water with fire-tubes, 3 and 5, passing through it to heat the water therein. The part that the Commissioner relies on is shown in Fig. 1 where there is a side wall of the fire box made of large tubes 79 leading at the upper end into drums 9 which form with the barrel 1 a tank for the water. The lower ends of the tubes 79 are connected into a header 58 which is also in communication with the tank 1. We have, therefore, simply a tank of a complicated shape, partly a plain horizontal cylinder, and partly a lot of vertical tubes, but no such circulating system as is involved in the Murray type.

The tubes 79 of McClellon are, as the specification says, "separated by fillers 89 which are welded thereto to make the wall complete." Does this patent supply the elements which were lacking in Griffiths to make up the combination of the claim? No, because the tubes 79 of McClellon are not the upright tubes "connected into the circulation of the generator" required by the claims. They are merely divisions of a large kettle or tank up which the steam goes into the top space. As the steam is consumed the water lever falls *in all parts of the boiler,* including the upright tubes. The loss of water is made up from an attendant outside tank, called the locomotive tender, and this is replenished at long intervals when the locomotive stops at a water tank on the roadside. Each of McClellon's upright tubes might as well be a separate kettle in which water boils. Lawrence said, page 73, "there is no circulation in the boiler shown on the McClellon patent.'' And again, "there is nothing to form a definite direction of flow in a boiler of this type. It is very haphazard. The steam comes up almost in any place.''

Asked whether this patent would lead one to use the same scheme for stationary boilers, Lawrence said, page 73, that it would not, that the McClellon construction is only a modification of the wall which has been used on locomotives for years and years; that is, the "hollow side wall'' type. For years and years, locomotive boilers have had the fire box surrounded by a double wall of steel with water therein, forming part of the whole tankful. McClellon instead of this unitary body of water merely divided it up into a number of separate bodies by means of his tubes.

In further support of his position, Lawrence added that if one applied this McClellon construction to the Griffiths patent, "it could not cure the objections which I have noted to the construction of the Griffiths patent. I would say that it would make the Griffiths boiler worse, as each tube would have to absorb more heat and, therefore, would require more water. As there is already a deficiency of water, the condition would be aggravated.'' The Griffiths boiler is safer with the large volume of water involved in laying the tubes up close together than it would be with the smaller volume present, if the tubes were spaced apart.

It is absurd to say that the imposition of the McClellon detail on the Griffiths boiler is obvious, when such imposition would *magnify the defects of Griffiths*.

Junkers Patent.—The Primary Examiner did not think this patent worth referring to. But attention was called to it by the Board of Appeals, page 120, as showing in Fig. 5 "walls of combustion chambers with pipes spaced apart and fins or webs connected with the pipes."

This construction fails of pertinence in several respects. It is obvious to the eye that the tubes 2 in the Junkers Fig. 5 are spaced apart a distance much greater than their diameter, three or four times as great, in fact. Nor are the extensions "limited in width as a maximum to the diameter of the tubes," as required by the claim. The extensions are as wide as several diameters of the tubes. This is an important, in fact a vital, distinction.

Also, the Junkers patent is not for a boiler furnace at all. It is in an art quite remote from that of the claimed invention. See the testimony of Lawrence commencing page 74. This Junkers patent does not say what the combustion chamber is for. There are hundreds of apparatus using furnaces with combustion chambers, which are entirely unrelated to boilers. Junkers refers, however, to a previous patent which, Lawrence tells us, does not refer to a steam boiler but to a hot water heater such as is "used in your home for heating hot water."

The importance of the spacing is brought out. The Junkers tubes

> "are spaced much too far apart for use in a boiler of the type we have been discussing. The plates would be much too wide to stand the excessive temperature of a boiler furnace, and excessive strains would also be set up by the temperature of these plates."

The construction would be absolutely inoperative. As the distance from the tube increases, the cooling effect of the water is less and the temperature of the metal rises. If you go far enough with the fins you will obviously arrive at a point where they would melt in the fire, because the melting point of steel is comparatively low. Even short of that, they would commence to crack and distort under the heat. Lawrence speaks from experience when he says, page 75:

> "The plates 5, even though they were not attached to each other, are *so wide that they possibly could not last long.* My prediction would be that those plates would *crack through to the tubes inside of two weeks, from our experience* with fins of the type that we have been using. That is because the plates are very much wider than the maximum diameter of the tubes."

If Murray had known about this Junkers patent and had ever thought of using it for his boiler wall, the spacing of the tubes and the width of the fins would have discouraged rather than encouraged him to do so. He would have had to make a modification which, though easy to see on paper, was not at all easy to conceive by an inventor feeling his way along an unlighted road.

The trouble with both McClellon and Junkers is that they cannot be taken *as they are* and added to the Griffiths structure. They must be modified in ways which are vital to success. A good anticipation cannot be built up out of these three patents. The inventor has still to incorporate vital points of departure before achieving success. The temperature of such a (Junkers) heater "wouldn't even be half the temperature of a steam boiler." The temperatures in these apparatus are so low as not to be comparable with that in a steam generator.

Breen Patent.—This patent is useful only to show that house heaters have been covered with heat insulating plaster embedding wire netting. But there is no suggestion that such a covering is applicable to water walls like those of Griffiths. The contrary is clear when we look at the Griffiths patent and realize that he supported his insulating casing on the floor, not on the furnace water wall, with an air space between them. Why should the Breen scheme be applied to the Griffiths water wall? If you will find in the prior art some suggested reason for doing so you may consider the Breen patent pertinent. But the suggestion has arisen in the mind of the Commissioner only out of the Murray patent application. It is an afterthought merely.

In conclusion as to all the patents, the testimony of Lawrence is as sound as it is clear. He said, page 75, referring to the four patents discussed above—

> "There is absolutely nothing, in my opinion, in these four patents in this book, plaintiff's exhibit 17, which would lead anyone to develop the wall as described in the Murray application.
>
> "In my opinion no engineer, exercising merely the usual skill of an engineer in this art, would, from a study of the four patents included in exhibit number 17, arrive at a boiler construction such as that of the Murray application or of boiler 51 at the Hell Gate station."

Other Efforts.—The court we think will take it for granted that there are a great many other patents in this art and that the Commissioner has cited only a selection of those that are most pertinent. Water cooling arrangements, for furnace walls and similar structures, are familiar in various arts.

Also, as stated by Mr. Leitch in ~~the extract from~~ Plaintiff's Exhibit 10, ~~referred to below~~, the embryonic idea of water cooling has been evidenced in some early types of boilers but never successfully developed, and lay dormant, neglected and forgotten. So that the style of boiler and furnace wall with which Mr. Murray had to deal was the fire-brick wall described above in the B. & W. Book.

Argument

The Murray Invention Has Advanced the Art.—The patent statutes are based upon the constitutional provision that the Congress shall have power "to promote the progress of science and useful arts, by securing for limited times to authors and inventors the exclusive right to their respective writings and discoveries" (Art. I, Sec. 8).

It was the intent of Congress, therefore, that a patent should be granted to one who had made a new invention, which has advanced the art to which it relates. The intent was that inventive contributions, which made for actual progress in the art, should be rewarded by the grant of a patent. The courts have always kept this principle in view in the construction of issued patents. In *Eibel Co.* v. *Paper Co.,* 261 U. S. 45, 63, Chief Justice TAFT said:

> "In administering the patent law the court first looks into the art to find what the real merit of the alleged discovery or invention is and whether it has advanced the art substantially. If it has done so, then the court is liberal in its construction of the patent to secure to the inventor the reward he deserves. * * * In the case before

us, for the reasons we have already reviewed, we think that Eibel made a very useful discovery which has substantially advanced the art. His was not a pioneer patent, creating a new art; but a patent which is only an improvement on an old machine may be very meritorious and entitled to liberal treatment.''

The Griffiths Patent Is Incompetent Because of Inoperativeness.—The record shows that power plant engineers, for a number of years prior to 1923, had been working diligently in an effort to increase the steam output of the boilers. It appears that these engineers were well aware of the fact that the deterioration of the refractory furnace walls was the limiting factor, which held down the steam output of the boilers. As soon as the Murray invention appeared in Boilers 51, 52 and 53 at Hell Gate Station, the engineers at once recognized this as the solution of their difficulties. They adopted and used it extensively. If, as contended by the Patent Office, the Griffiths patent, No. 743,271, issued November 3, 1903, discloses substantially the Murray invention, why was it that these engineers had not employed the Griffiths boiler to solve their difficulties? The Griffiths patent had been accessible to the public for twenty years prior to the Murray invention, and yet nothing has ever been done with it. Mr. Lawrence testified that he had made inquiries and had been unable to find any evidence of the use of the Griffiths boiler. What we have said above regarding the inoperativeness of the Griffiths boiler, explains why that boiler was never used. It tells us why engineers never adopted the Griffiths construction. Any engineer skilled in this art, upon a casual examination of the Griffiths patent, would see at once that the construction is worthless, impractical, inoperative and dangerous, and would have nothing more to do with it. This patent disclosed nothing worthwhile and was, in fact, a nullity in the art.

It is a well-known principle of the patent law that a prior patent or publication, describing an inoperative structure, cannot anticipate a later invention which has proved a success and actually advanced the art. In *Walker on Patents*, 6th Ed., p. 128, this principle is stated as follows:

> "Novelty is not negatived by anything beneficially incapable of the function of the subject of the patent, even though apparently similar thereto."

In *Cimiotti Unhairing Co.* v. *American Unhairing Co.*, 115 Fed. 498, the Circuit Court of Appeals for the Second Circuit said, regarding some of the references set up as anticipations of the Sutton patent in suit:

> "Indeed, there is nothing in the record to show that the Lake machine could successfully unhair a pelt. No one ever saw it operate. It began and ended its uneventful career in 1881. For nearly 20 years it remained nothing but an ambiguous description of incomprehensible drawings. It emerged from oblivion solely to meet the exigencies of this litigation. Were it not for the drawings the specification might be understood and were it not for the specification the drawings might be understood; but united they form a document which demonstrates that its author was either ignorant of the English language or of the essentials of a successful unhairing machine. The Lake patent antedates both Sutton and Covert; since its date the unhairing of pelts has assumed

> enormous proportions and fortunes have been made in the business, and yet we are asked to believe that there was a machine which could successfully do the work and thus levy an enormous tribute upon the entire art. The inquiry is pertinent, why was it that this machine was permitted to remain unused?"

In *Kirchberger* v. *American Acetylene Burner Co.*, 124 Fed. 764, Judge RAY of the Circuit Court of the Northern District of New York, said (p. 777):

> "When a patented process or machine proves a failure, is inoperative, and another follows, and is a success in its operation, the latter is a new invention and patentable, even though we have the same machinery or parts of machinery, but they are combined or put together in a new way; and this is true even if the latter combination closely follows and resembles the first, provided there be a difference. In such case it is evident that the later patentee has succeeded where the other failed; that he has discovered or invented the desired thing to accomplish a new and a useful result; that his change, however unimportant it may seem to the observer, is the key to the whole situation. In such case the defense of anticipation, of prior use, or prior invention is not made out."

All the cases show that the courts do not look with favor upon attempts to find, in an earlier patent disclosing a worthless and inoperative structure, an anticipation of a later invention which has proved its worth and demonstrated its real value to the art. The very worthlessness of the Griffiths boiler shows that it could not have embodied the Murray invention. Therefore, it should not be considered an anticipation.

Moreover, the claims of the Murray application are so drawn that they distinguish clearly from the structure disclosed in the Griffiths patent, in that very particular which makes the difference between success and failure.

Authorities on Invention.—We recognize that decisions are not of great assistance in determining the question of invention. Nevertheless, it may be helpful to refer to a few authorities, in which the Supreme Court has indicated some of the principles that assist in deciding that question.

The commercial history of the invention has always been considered a factor of importance, in determining whether the advance in the art constituted invention. In this case, we have the fact that engineers, prior to Murray's invention, were trying earnestly to increase the steam output of their boilers, but found themselves held back by the refractory furnace walls. They were at a standstill. Any further increase in steam output merely meant excessive costs in repairing and replacing the furnace walls, and that was economically unwise. Then Mr. Murray, in Boilers Nos. 51, 52 and 53 at Hell Gate Station, showed the art how the boiler construction could be changed to eliminate this restriction. The result was that he was able to double the steam output of the boilers, and that without any deterioration of the furnace walls. The engineers in the art, although skeptical at first, finally recognized the value of this contribution and adopted it, so that, today, walls such as Murray first put into use, have become the established practice and the refractory walls are obsolete. A very large sum of money has been paid for the exclusive right to build and use such furnace walls. The trade publications recognized this as Mr. Murray's contribution, and called it an invention. The Griffiths patent had been in existence for twenty years prior to that time, but it had never taught anyone anything. At most, it taught the art what not to do. This fact situation is one to which the words of the Supreme Court in *Carnegie Steel Company* v. *Cambria Iron Company,* 185 U. S. 403, 429, are particularly applicable. Mr. Justice Brown said:

> "It is true the Jones patent is a simple one, and in the light of present experience it seems strange that none of the expert steel makers, who approach so near the consummation of their desires, should have failed to take the final step which was needed to convert their experiments into an assured success. This, however, is but the common history of important inventions, the simplicity of which seems to the ordinary observer to preclude the possibility of their involving an exercise of the inventive faculty. The very fact that the attempt which had been made to secure a uniformity of product, seems to have been abandoned after the Jones invention came into popular notice, is strong evidence tending to show that this patent contains something which was of great value to the manufacture of steel, and which entitled Jones to the reward due to a successful invention."

One of the results flowing from the use of the Murray invention has been a marked increase in the output of steam boilers. The courts have always been ready to see invention in changes which resulted in increasing productiveness of prior machines or apparatus. In

Eibel Company v. *Paper Company,* 261 U. S. 45, the Supreme Court sustained a patent which resulted in greatly increasing the productiveness of a paper-making machine. The change appeared to be a very simple one, consisting merely in increasing the elevation of one end of the paper-making wires. Nevertheless, since this change was not obvious to the workers in the art, and was immediately adopted by them after it was made known by the patentee, with a resulting increase in the production secured from the machine, the Supreme Court decided that the patent covered a valuable invention and one entitled to liberal construction.

In *Loom Company* v. *Higgins,* 105 U. S. 580, the patent was for certain improvements in a loom. These improvements made it possible to produce ten yards a day more from each loom. The Supreme Court found that this was a new and beneficial result, and evidence of invention. The Court said (p. 591):

> "At this point we are constrained to say that we cannot yield our assent to the argument, that the combination of the different parts or elements for attaining the object in view was so obvious as to merit no title to invention. Now that it has succeeded, it may seem very plain to any one that he could have done it as well. This is often the case with inventions of the greatest merit. It may be laid down as a general rule, though perhaps not an invariable one, that if a new combination and arrangement of known elements produce a new and beneficial result, never attained before, it is evidence of invention. It was certainly a new and useful result to make a loom produce fifty yards a day when it never before had produced more than forty; and we think that the combination of elements by which this was

> effected, even if those elements were separately known before, was invention sufficient to form the basis of a patent."

In the case at bar, the claims are for a combination of elements. The combination cannot be anticipated by showing that the elements, individually considered, are old. It is presumed that the elements are old. The Patent Office, however, has failed to show any prior instance in which these old elements were combined in the manner claimed in the Murray application, so as to cooperate in producing this new and beneficial result. The connection of the side wall tubes into the circulation of the generator is an essential characteristic of this new combination. It is one of the features which brought the success of the Murray invention. Griffiths lacked this essential feature. That is why the Griffiths boiler was a failure. We submit, therefore, that the claims of this application were improperly refused by the Commissioner of Patents, because the prior patents relied on by him do not disclose this new combination of elements, connected and co-operating as in the Murray application to produce this new and beneficial result.

The point is well put in a recent opinion of the Circuit Court of Appeals for the Seventh Circuit in *Lakeshire Cheese Co.* v. *Shefford,* 72 F. 2nd 497, 499—

> "Whether a patent involves invention is to be determined in the light of *historical facts* rather than what might appear to be simple in the light of *hindsight.*"

The Allowed Claims Are Insufficient.—Claims 20 and 24, which have been indicated as allowable, are good claims but unduly restricted. Each of them includes the limitation that the metal extensions from the tubes shall be "free to move separately." This is a valuable feature, in building furnace walls of any considerable size, but it is not the essence of the Murray invention. If these two claims only should be allowed, and the remaining claims of this application rejected, the public would have a right to say that all Murray contributed to the art was the idea of providing metal extensions from the side wall tubes, which should be free to move separately. He did contribute this idea, but it was not all that he contributed. It was not the mere freedom of the tube extensions or fins to move separately, that caused the Murray boilers at Hell Gate Station to achieve such remarkable success. It was, rather, the presence in these boilers of the underlying conception of side walls composed of tubes, connected into the circulation of the steam generator, spaced apart with fillers between them so that the water circulating through the generator would be caused to flow rapidly and positively through the tubes without too greatly retarding combustion in the furnace.

Mr. Lawrence has testified that, in his judgment, it would not be the best practice to build such a water wall, in which the fins were not free to move separately, but it is not at all impossible that someone may devise a practical water wall, in which the fins on the tubes are not free to move separately, or, at least, in which that would be a debatable question. To focus attention upon the separate movability of the fins, as if that were the Murray invention, is to lose sight of his broader contribution to the art, which was the idea of a wall composed of tubes connected into the circulation of the generator. We submit that the patent to issue on this

Murray application should not be restricted to detailed claims, important though such details may be. Some of the claims allowed, at least, ought to be so drawn as to point out the essential feature of the invention.

Conclusion

We maintain, therefore, that Thomas E. Murray made a contribution which has substantially advanced the art of power plant boiler construction when he devised that combination of elements which was first disclosed in the present application and embodied in Boilers 51, 52 and 53 at Hell Gate Station. Before that, the applied art knew only refractory walls, with their inherent limitations. After the success of these Hell Gate boilers, the art abandoned the refractory furnace wall construction and adopted that contributed by Mr. Murray.

His invention was recognized as such, both in the trade publications and, also, by the license agreement with International Combustion Engineering Corporation and the substantial royalties paid thereunder.

The Griffiths patent is proved to be worthless, inoperative and dangerous. It cannot possibly anticipate the Murray claims. It lacks the essential characteristic of a circulation, into which the side wall tubes are connected. The Commissioner based his refusal of a patent to Murray upon this Griffiths patent, and that is the ground upon which this suit has been defended. Since it has been shown conclusively that the Griffiths boiler is inoperative, and since the claims of the Murray application are limited in express terms to tubes connected into the circulation of the generator, they cannot possibly cover the Griffiths boiler, and the refusal of the patent was clearly in error.

In particular, Claims 19, 21, 23 and 25, which refer to the spacing of the tubes and metal fillers between them, describe the particular type of wall which, in combination with the overhead tubes of the old type of water tube boilers, were responsible for his great success. A new combination which achieves such extraordinary results cannot be fairly anticipated by a reference built up out of selected pieces from prior patents in different branches of industry.

We submit, therefore, that plaintiff is entitled to a decree as prayed.

Respectfully submitted,

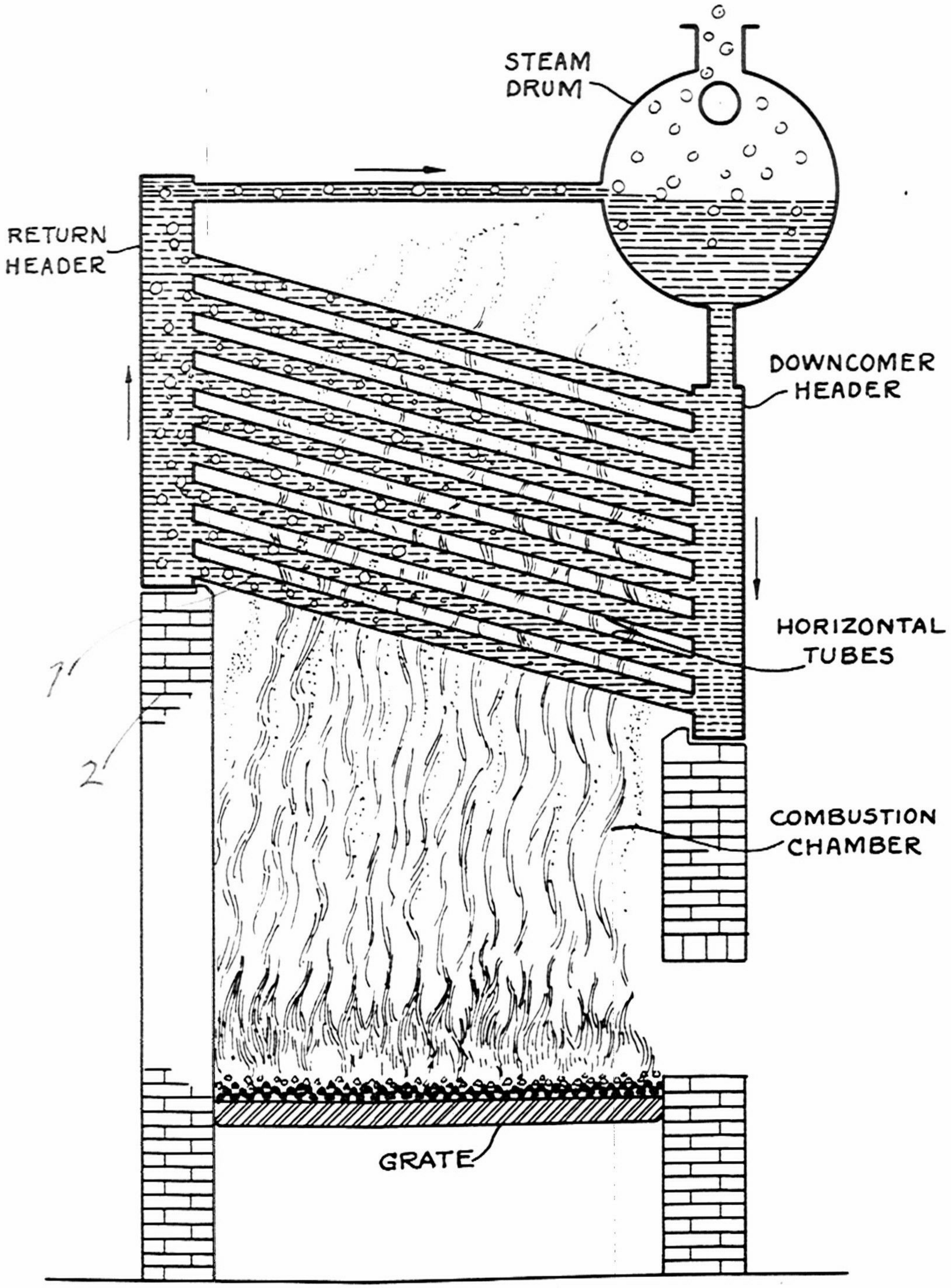
MELVILLE CHURCH,
D. ANTHONY USINA,
C. B. DES JARDINS,
Counsel for Appellant.

Washington, D. C., November 6, 1934.

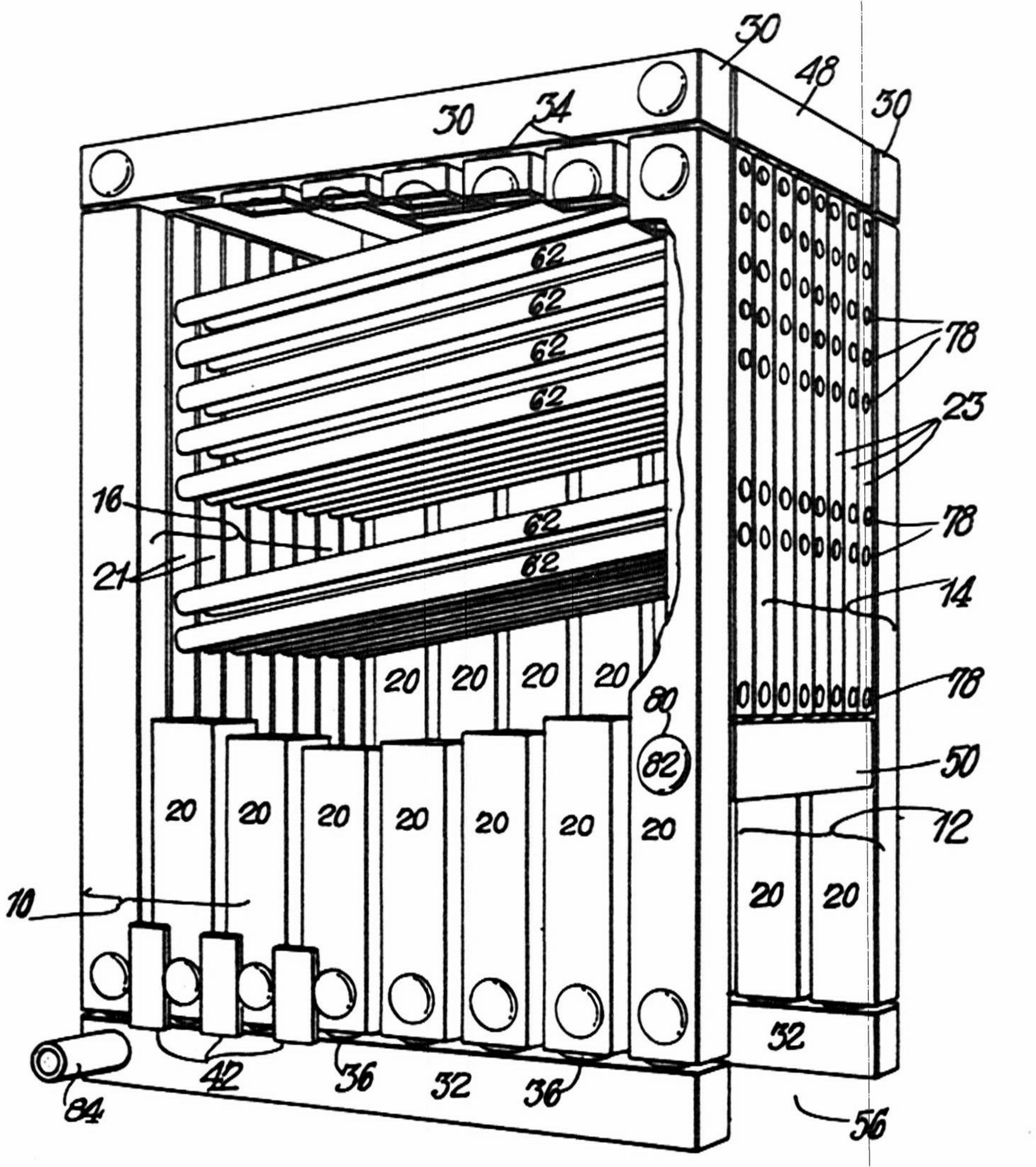
APPENDIX I

COMPARISON BETWEEN OLD STANDARD FURNACE WALL AND MURRAY IMPROVEMENT

RETURN HEADER EXH. 15.



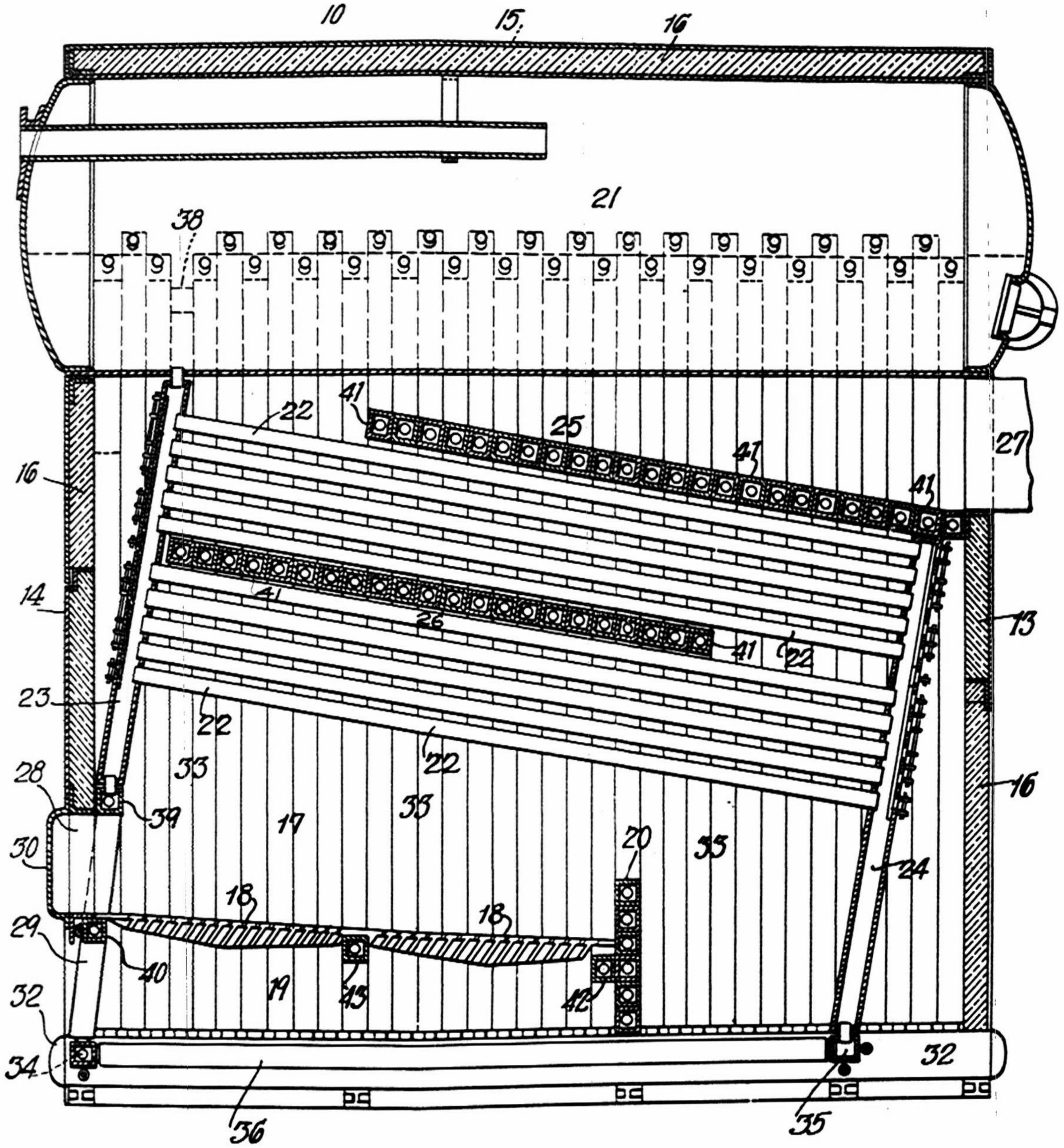
MURRAY WALL FIG. 1.



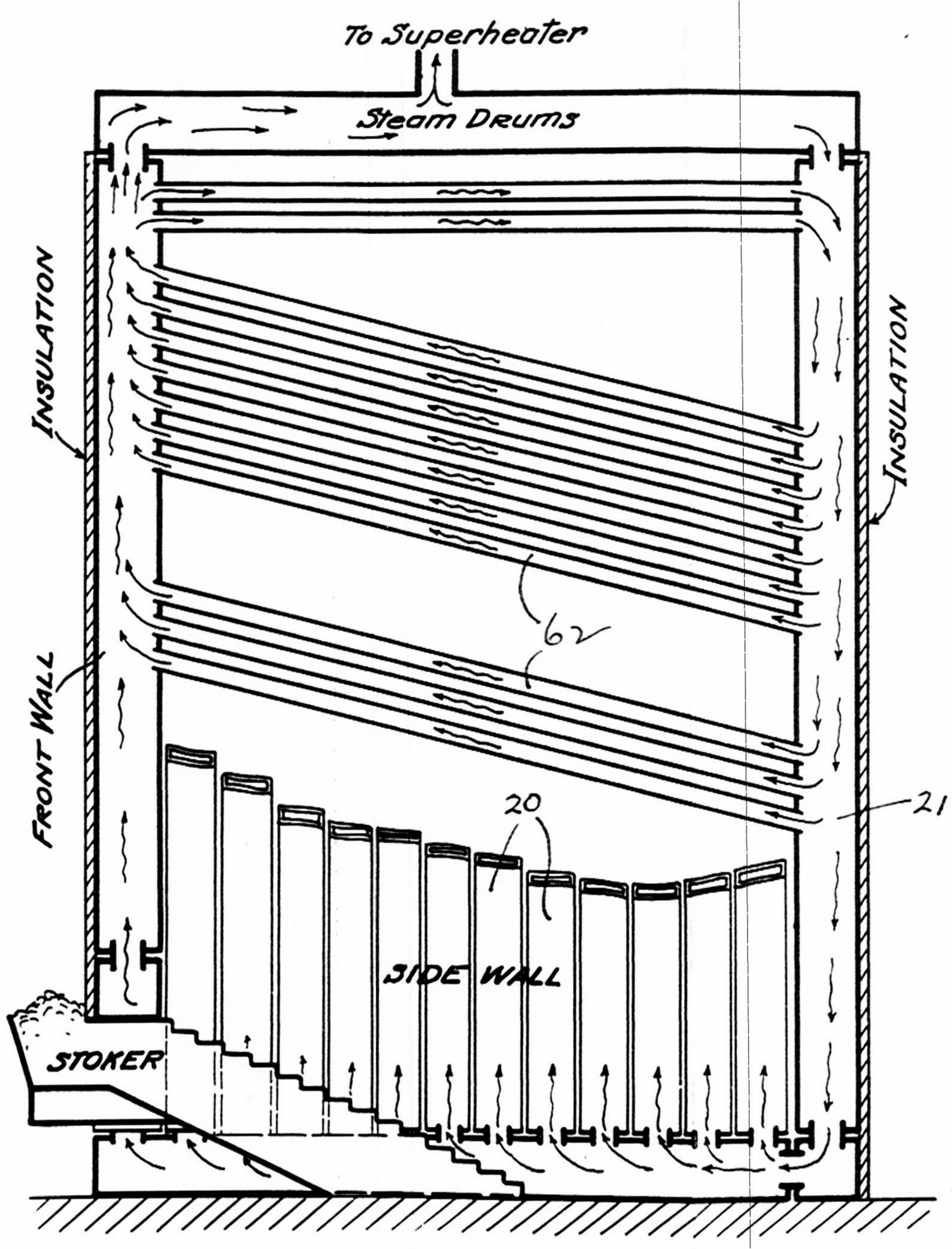
APPENDIX II

COMPARISON BETWEEN GRIFFITHS AND MURRAY CIRCULATING SYSTEMS.

GRIFFITHS FIG. 5.



MURRAY EXH. 3-C.



UNITED STATES
COURT OF APPEALS
DISTRICT OF COLUMBIA

FILED NOV 2 1934

Henry W Hodges

No. 6278

In the United States Court of Appeals for the District of Columbia

Metropolitan Engineering Company, appellant

v.

Conway P. Coe, Commissioner of Patents,
appellee

APPEAL FROM THE SUPREME COURT OF THE DISTRICT OF COLUMBIA

BRIEF FOR THE COMMISSIONER OF PATENTS

T. A. HOSTETLER,
Solicitor United States Patent Office.

In the United States Court of Appeals for the District of Columbia

OCTOBER TERM, 1934

No. 6278

METROPOLITAN ENGINEERING COMPANY, APPELLANT
v.
CONWAY P. COE, COMMISSIONER OF PATENTS,
Appellee

APPEAL FROM THE SUPREME COURT OF THE DISTRICT OF COLUMBIA

BRIEF FOR THE COMMISSIONER OF PATENTS

SUBJECT-MATTER OF THE APPLICATION

The claimed invention relates to a water-tube boiler having tubes 62 heated by convection connected to members 21 and 23 which are connected to headers 48 and 50. Members 20 form the side of the fire box and are connected to headers 30 and 32. The members 20 are spaced apart a distance not substantially greater than their diameter, and the spaces between same are closed by metal members 42 as shown in Fig. 5, or by overlapping fins 100 as shown in the preferred construction in Fig. 11. The members 42 or 100 are connected to the tubes with good heat-conducting joints. The members 20, 21, and 23 form the walls of the combustion chamber. Upon the outer side of the wall, formed of the members 20, 21, and 23, there is insulating material 74 attached thereto by means of the wire mesh 76.

THE REFERENCES

The patent to Griffith, 743271, shows tubes 22 heated by convection and connected to headers 23 and 24. The side walls of Griffith's device are formed of tubes 33 connected to header 32 below the drum 21 at the top. The headers 23 and 24 and the tubes 33 are placed in such close relation that they form walls for the combustion chamber. At the outside of the tubes, but not attached thereto, is an asbestos covering 16.

The patent to McClellon, 1474156, shows a locomotive fire box formed of tubes 57 connected to lower headers 58 and upper drums 11 (Fig. 2). The tubes are spaced a distance apart not greater than their diameter and the spaces between same are closed by filler strips 75 (Fig. 2) welded to the tubes, as stated on page 3, lines 18, et seq. The outer faces of the walls are covered with asbestos which is protected by the plate 89. Tubes 79 (Fig. 1) form the side walls.

The patent to Junkers, 1125113, shows in Figure 5 walls of a combustion chamber formed of tubes 2 spaced apart and fins or webs 6 connected to the tubes and filling the spaces therebetween.

The patent to Breen, 590962, discloses a heater covered with a nonconducting material, such as a plaster, in which asbestos forms a large part and which is reinforced by a wire netting *w* as stated on page 2, lines 57, et seq. of the Breen specification.

ARGUMENT

The patent to Griffith shows the general combination claimed to be old, that is, a water-tube boiler having inclined tubes positioned over a fire box, with the fire box formed entirely of tubes and insulating material at the outer side of the tubes, as above pointed out in the description of the patent. Plaintiff has substituted, for the wall tubes of Griffith, another old and well-known type of tube construction, shown to be old by McClellon or Junkers. In other words, he has substituted spaced water tubes with metal webs or fins closing the spaces therebetween and welded to same so as to provide good heat conduction thereto, as taught by the said McClellon and Junkers patents. He has also used the insulation applied to the outside of the tubes also shown by McClellon.

The Griffith patent shows the basic idea of surrounding a water-tube boiler with an imperforate wall formed of water tubes connected into the circulation of the boiler.

Appellant sets forth two main contentions for the patentability of the claims based upon the steam generator disclosed in the Murray application in this appeal. One is that the Griffith patent, used as a basic reference, is inoperative; and the other is that the boilers installed in the Hell Gate Station in New York met with great success and renown in the Boiler World.

It may be helpful to point out, in the very beginning, that the boilers of the Hell Gate Station, that evidently made such great impression on the Boiler World, were of a greatly different design from that of the boiler in this appeal. Appellant's Exhibit No. 4 shows the construction of the Hell Gate boilers, with proper provision made for circulation of fluid to and from the water wall tubes, by way of downcomers E and upcomers, leading from upper header G to the steam drum of the boiler. The downcomers are outside the boiler furnace, and are unheated, so that a downflow of water would be produced therein. The upcomers are separate from the boiler circulation, in that they lead back to the drum independently of the main water and steam conduits of the boiler. Such connections, no doubt, do give the proper circulation for the water tubes; but in the boiler in suit no such connections are provided; all the wall tubes in the furnace are heated by intense radiant heat; and, according to appellant's diagram 2, in his Exhibit No. 14, all such wall tubes would tend to have an upward circulation of steam and water therein, as explained in appellant's argument in its brief on page 27, last paragraph. The wall tubes or headers 21 are the sole source of appellant's recirculated water; and, since, according to its own argument, the water would tend to flow upwardly in tubes 21, such source of supply is clearly unreliable. Appellant has provided no other path for downflow of cold water in his boiler, whereas Griffith does have several wall tubes 33 at the front and rear of the furnace shielded by headers 23 and 24 from the radiant heat, and kept at a comparatively cool temperature thereby, where water can flow downwardly, at least to a slight extent, as admitted by appellant's witness (Record 76, line 33).

Appellant has adduced no evidence that the boiler of the application was ever built or operated. The exhibits of the actual installations all evidently disclose the type of boiler installed in the Hell Gate Station which is shown in appellant's Exhibit No. 4 and which is not the boiler of the application.

Referring now to the structure and operativeness of the Griffith boiler. It is pointed out that the general combination claimed is present in the patent of a boiler with the furnace surrounded on all sides by vertically extending water-wall tubes connected into the circulation of the boiler. The structure of the patent is almost a complete parallel to appellant's boiler now in suit. The patent has front and rear headers 23 and 24 that contact and form a wall entirely across the boiler furnace. Tubes 22 connect these headers in the same manner as appellant's tubes 62. Side-wall tubes 33 are placed on both sides of Griffith's furnace and lead upwardly from lower header 32 just the same as appellant's tubes 20 lead upwardly from lower header 32 to the upper header 30. The main difference is that appellant's wall tubes, including tubes 21, are all intensely heated, which has a tendency to retard downward circulation since all natural boiler circulation is dependent upon the principle of thermo-syphonic circulation so well explained by appellant. However, Griffith has at least three comparatively cool tubes 33 on each side of his boiler leading from below the steam drum 21 to the lower header 32, which tubes are blanked off by headers 23 and 24, one tube at the front behind header 23 and two at the rear behind header 24. Clearly, there would be a downward circulation in such cool tubes. Appellant states (page 28 of its brief, lines 4 and 5) that counsel for the Commissioner "invented the theory that at the rear end of the boiler the tubes 33 would be colder than at the front end of the boiler and that this might induce the desired circulation." This is clearly not an invention on the part of appellee; but a corollary falling directly under appellant's theory, expounded with reference to figures 1 and 2 of Exhibit 14 (R. p. 61, first two paragraphs). This is a basic principle of all thermo-syphonic circulation. Griffith's boiler evidently falls under the principle illustrated in Fig. 1 (R. opposite p. 120). Appellant's theory of operation of Griffith's boiler given in its brief, page 27, lines 14 to 22, is merely a supposition on its part and is not one that the inventor describes. Appellant contends (page 28 of its brief, line 10) that flame would heat the tubes 33 at the right hand of Griffith's boiler; but flame cannot extend up this far, since such flame would have to travel between the boiler tubes 22 and pass over the upper ends of wall tubes 33 and out of stack 27. Further, the baffle 26 does not (as contended by appellant, page 28, line 29 et seq.) direct the flame against the outermost tubes 33, because such outermost tubes are blanked off from the flame and radiant heat by headers 24 and are shielded by same. Clearly, the Griffith boiler would be operative. Appellant contends that the Griffith boiler was not built nor put into extensive use. It is not necessary that a patent be reduced to a physical embodiment to anticipate a claim. It is submitted that if the Griffith boiler is inoperative, as urged by appellant, page 26, then appellant's boiler of the application is obviously inoperative for like reasons. In each case the tubes of the four walls of the boiler surround or form the fire box and are subject to direct heat from the fuel in varying degrees. The steam pressure in the boiler would permit no vacuum to form in the bottom tubes. The excessively heated tubes would conduct steam to the top and the tubes less exposed to the heat would conduct cool water to the bottom, which latter tubes would be cooled by the flow of water through them.

Since the Griffith patent meets the terms of the general combination, the only difference of the claims thereover lies in the specific wall construction. Appellant has used wall tubes spaced apart with overlapping fins 100 or filler pieces 42 therebetween and welded thereto, with asbestos applied to the outer sides of his tubes. This is clearly shown in the McClellon patent (Fig. 2) to be old structure for a boiler fire box. The Breen patent shows the application of plastic insulation to the outside walls of a boiler, as used by appellant, to be a very old expedient. Appellant states, page 38 of its brief, lines 1 to 3, that "there is no reason in the world why a power-plant engineer should look into the art of locomotive fire-tube boilers for helpful hints." However, in the decision in *Universal Arch Company* v. *American Arch Company*, 1924 C. D., 424, 290 Fed. Rep. 647 (cited in appellee's brief), the lower court held that "no invention would result from the transfer of a brief baffle from a water-tube boiler to a locomotive fire box, unless some distinctly new function were performed or some new and useful result or advantage were achieved." In other words, it is evident that a boiler engineer should at least be apprised of all developments taking place in the field of boilers; and that the teaching presented by locomotive structure may be used in a water-tube boiler or *vice versa*.

Appellant states that, by using spaced tubes connected by fins, (page 35 of brief, next to last paragraph) a smaller body of water is brought in contact with furnace heat, and, hence, affects a much higher rate of heat transfer, resulting in increased circulation and steam generation, and decreased cooling effect of the tubes on the combustion in the furnace; but all of these results are present in McClellon; and if the McClellon type of wall tubes were incorporated in the boiler of Griffith, it would produce only these expected results. No drastic change in Griffith is required. His tubes 33 would merely have to be spaced apart and united by filler pieces and insulation placed at the outer sides thereof. This is all taught by McClellon and by the patent to Junkers, 1125113. Appellant's witness stated in substance (R. page 75, lines 7–18) that it is bad to have the plates attached together and to the tubes, since they might tear apart due to expansion and contraction strains. Hence, it was thought that Murray did advance the art by providing *overlapping* fins free to move relative to each other due to expansion and contraction of the elements. Claims on this feature were, accordingly, allowed in the case at bar.

Whatever the erroneous opinion of Mr. Lawrence and other engineers may have been on the question of impracticability of tubes for boiler walls, it must be admitted that Griffith, 743271, and McClellon, 1474156, disclosed tubes for boiler walls long before appellant here gave that discovery to the public. It appears that appellant built a boiler with tubes for walls as disclosed by Griffith and by McClellon and found that it worked notwithstanding the adverse opinions of the experts that holes would be burned in the tubes.

HOW COOL ARE APPELLANT'S DOWNCOMER TUBES?

The arrows in appellant's Exhibit 3C indicate that the flow of the water is upwardly both in the tubes of the side walls, and in the "Front Wall", and downwardly only in the rear wall (marked 21 opposite page 112). In Fig. 2 of the Murray application drawing we find the rear tubes 21 form the rear wall of the combustion chamber and subject to the direct heat of that chamber. The baffles 64 then conduct the flames against intermediate portions of the tubes 21, and finally the upper ends of the tubes form in effect a wall of the flue opening at 66. Even a layman would see that the tubes 21 are subjected to excessive heat and that they would not be very efficient in promoting a downward flow of water. It is therefore apparent from appellant's own disclosure that any contention of inoperativeness appellant urges against the Griffith patent applies with equal or even greater force to the Murray application.

THE CLAIMS

The claims are found on pages 108 et seq. of the Record. The Examiner's Statements begin on page 113. The decision of the Commissioner begins on page 119.

Claim 19 appears to be typical. A careful reading of this claim, it is submitted, fails to disclose a single feature of patentable novelty over the prior art of record, and the corresponding elements function in all essentials like the elements recited in the claims. This claim recites (1) "approximately horizontal water tubes." These are shown by Griffith at 22. (2) "a combustion chamber below." Note the grate 18 of Griffith. (3) "combustion chamber * * * composed of substantially upright tubes * * * spaced apart." Griffith shows the chamber so formed (not spaced apart), of tubes 33, 23, and 24, that contact with each other, but McClellon discloses spaced-apart tubes 87 and 89 forming the walls of the combustion chamber of a boiler. (4) "metal extensions." Such extensions as disclosed by Junkers in Fig. 5 and also by McClellon on page 3, lines 16 to 24 of the McClellon specification. (5) "insulating material." This is disclosed by McClellon, page 3, lines 58 to 61, and also in the Breen patent. Breen was cited merely as disclosing wire mesh in connection with the insulating material. The remaining claims can in like manner be fairly well read upon the same prior patents as construed by a person reasonably skilled in the steam engineering art.

The claims are not limited to any particular type of steam generator, whether large or small, but cover all types. Appellant is obviously not entitled to the credit of having been the first to disclose a steam generator wall formed of tubes. If appellant Murray has revolutionized the steam-boiler art, as proclaimed on page 3 of appellant's brief, then that alleged discovery must be sought elsewhere than in the disclosure of the application here before the Court.

To sum up, it is pointed out that the many references to the beneficial results produced by Murray's water wall all relate to a type of water wall that is separated from the main boiler and connected thereto by circulating connections, such as the one used in the Hell Gate Station boilers pictured in Exhibit 4. There is no proof that the boiler in suit made any more impression on the Boiler World than did the Griffith patent. Appellant in its brief (page 44, last two lines, and page 45, first three lines) states that, "any engineer skilled in this art, upon casual examination of the Griffith patent, would see at once that the construction is worthless, impractical, inoperative, and dangerous and would have nothing more to do with it." This is apparently what Mr. Lawrence first thought of Murray's idea of placing water tubes in the wall of a furnace as set out on page 14, lines 18–28 of the brief. Apparently it was not so much the concept of the idea of using a water wall in a furnace as it was Murray's determination to put it into use that made his wall in the Hell Gate Station a success.

In conclusion it is submitted that the boiler disclosed in the Griffith patent is operative and presents the basic combination of the claims that have been refused, and it is further submitted that if the side walls of Griffith were spaced apart as taught by McClellon, no new and unexpected result would obtain.

It is respectfully submitted that the decree of the Court below should be affirmed.

T. A. HOSTETLER,
Solicitor for the Patent Office,
Attorney for Appellee.

NOVEMBER 1934.

U. S. GOVERNMENT PRINTING OFFICE: 1934

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Henry W Hodges
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United States Court of Appeals

For the District of Columbia

October Term, 1934

No. 6278

METROPOLITAN ENGINEERING COMPANY
Appellant

v.

CONWAY P. COE, Commissioner of Patents
Appellee

REPLY BRIEF FOR APPELLANT AND MOTION FOR LEAVE TO FILE

APPEAL FROM THE SUPREME COURT OF THE DISTRICT OF COLUMBIA

Melville Church
D. Anthony Usina
C. B. Des Jardins
Counsel for Appellant

United States Court of Appeals

For the District of Columbia

October Term, 1934

No. 6278

Metropolitan Engineering Company,
Appellant,

v.

Conway P. Coe, Commissioner of Patents,
Appellee.

REPLY BRIEF FOR APPELLANT

We beg leave to call the attention of the Court to the following points in the Commissioner's brief which, in our judgment, are either in error or misleading for insufficiency:

(1) Page 2, under "The References," the Commissioner's brief refers to "an asbestos covering 16" in the Griffiths patent. This description is not accurate. The asbestos 16 is merely a lining on an outside casing 11, 12, 13, of metal. This casing and its asbestos lining are clear of the water tubes. It is not "united to and supported by" the water walls as required by appellant's claims. In fact the metal plates and the asbestos lining are mere substitutes for the old style refractory brick casings, whose elimination is the chief accomplishment of the present invention.

(2) At the top of page 3, the Commissioner's brief refers to the Breen patent as showing "wire netting *w*" which reinforces the plastic covering of the casing. But this reinforcement is not united to the wall of the Breen heater as required by appellant's claims and shown most clearly in his Figs. 3 and 4.

The limitation in the claims to insulating material united to and supported by the walls is not a trifling detail. It is of very substantial practical importance. There is often a pressure of combustion gases in furnaces. In these large furnaces, such pressure amounts to a large total. Also it is at times pulsating, and therefore more troublesome. The insulation must be firmly attached to the water wall to avoid its being blown off and shaken down by such forces.

(3) It is not correct to say, as the Commissioner's brief does on page 4, that the famous boilers of the Hell Gate Station were of a "greatly" different design from that of the boiler in this appeal. Exhibit No. 4, to which the Commissioner refers, is a sectional view of the Hell Gate boiler as actually built. The view contains a number of details which might be confusing.

We attach a sketch illustrating only the circulation, which is the matter in controversy. The water comes down from the "Steam Drum" through the tubes A and the "Downcomer Header" B. These are familiar parts of all standard water tube boilers. The heated water and steam in the inclined "Horizontal Steam Generating Tubes" C naturally rises to the higher end and thus induces a suction downward in the downcomer header and an upward flow in the "Return or Front Header" so that the steam therefrom passes up and across to the steam drum. The downcomer headers B are connected at their lower ends to a cross drum entitled "Mud Drum" D. From this drum D part of the water passes by an outside pipe E downward into the projecting end of the "Bottom Header" F, thence it passes up by the "Vertical Tubes of Water Wall," shown at the far side, into the "Upper Header" G. From this header the hot water mixed with steam passes out at the right and through the pipes X to the steam drum.

In the design of Murray's patent application there are only two departures from the actual Hell Gate boiler:

(a) Instead of carrying the water down from the downcomer headers by a separate pipe (E) running across to the opposite side, the water was carried straight down by a continuation of the downcomer header (B). We have indicated this straight continuation in dotted lines at (Y). When the boiler came to be built actually, the cross pipe (E) was put in in order to allow for expansion and contraction. It is common in water and steam pipes of substantial length to provide bends which allow contraction and expansion without breakage of the pipe joints. That is why this expedient was adopted in the boiler as actually built.

(b) Instead of carrying the water from the "vertical tubes of water wall" ~~tubes (A)~~ through the "return or front header," it also is carried by the cross "upper header (G)" and separate pipe (X) to the steam drum. This is for a similar reason to that which actuated the bending of the downcomer.

In the upward leg of the circuit it makes no difference whether all the steam-bearing water passes up through the "return or front header" of the standard boiler, or through the separate pipe (X). Obviously the "return or front header" through which applicant proposes, in his patent application, to conduct the rising fluid, is more exposed to heat than the outside tube (X) and would tend to expedite the circulation as compared with the Hell Gate boiler; though the difference is slight.

Similarly, in theory, the outside pipe (E) which formed part of the downward leg of the circuit in the Hell Gate boiler would tend to improve the downward flow because it is outside of the wall and, therefore, cooler; but here again the difference would be slight.

The differences then amount to this:—The Hell Gate boiler had part of the downcomer circuit on the outside which, being cooler, would tend to encourage the desired circulation; and the upgoer had a part of about equal length outside of the boiler which, being cooler, would tend to retard the circulation. The net result of these two departures, as far as their influence on the circulation was concerned, was practically zero.

If we bear in mind that this invention is an improvement on the standard boiler, represented by the upper part with its horizontal tubes, slightly inclined with water flowing down through headers to the lower ends of such tubes and steam-bearing water flowing up through other headers from the upper ends of these tubes, we see that there is already a strong force making for a downward circulation through the "downcomer headers" which would carry the water straight down to the bottom header (F) through such a tube as we have indicated at (Y). This is one reason why the inventor, in his initial sketches and in his application for patent which was prepared therefrom, merely indicated the downward part of the circuit as a straight tube in line with the downcomer headers of the overhead structure. This would be true even though the rear end water wall were heated.

It is apparent from Fig. 2 of the patent application that the heat from the grate fire at 58 is least effective against the back wall 21. The refractory diaphragm or baffle 64 in the overhead tubes confines the flame largely to the front of the boiler.

Bearing in mind the salutary principle of the law that patentees are expected to file their applications as soon as they have a complete workable conception and that they are not expected to illustrate the exact forms in which it is practically embodied in further development, we submit that applicant's disclosure here is quite sufficient to justify crediting him with the fame which came to the Hell Gate boiler.

4 ([illegible]) The above discussion is based on a comparison of the applicant's disclosure and the Hell Gate boiler. It is quite separate from the additional point raised by the Commissioner that, if the Griffiths boiler won't work, neither will that disclosed in the Murray application. This theory of Commissioner's counsel is not soundly based upon the facts.

In applicant's boiler, as illustrated in his patent application, we do not have the simple case of a loop with both legs exposed to the same heat as in diagram 2 of Exhibit No. 14. We have on the contrary an overhead boiler with a standard circulation and we have extended the downcomer of that standard boiler to permit the water therein to flow clear to the bottom of the furnace.

We have placed this continuous downcomer at the back of the furnace where, by reason of baffles, the heat is less than at the front, and we have made this downcomer extension of much less height (and corresponding lifting tendency) than the tubular side wall, which lack of balance further contributes to the circulation.

This last point may be more fully explained, thus:— In any circuit having two legs there will be a circulation if the uplifting force in one is greater than that in the other. In the drawing of the Murray application there is a greater uplift in the side wall tubes than in those of the back wall. This is because the side wall tubes are longer than the back wall tubes. The side wall tubes are, therefore, exposed to a much greater quantity of heat. This effect is magnified again by the location of the rear wall tubes and the overhead baffle, as explained above. Thus the side wall tubes are hotter and have a greater surface exposure to the fire and the fluid within them is subjected to a greater uplift than that in the rear wall tubes.

Let us compare these conditions with those in the Griffiths boiler, Fig. 5. Griffiths' only rear wall tubes (comparable to the rear downcomer walls of the Murray boiler) are the tubes 24. *But these are not downcomers at all.* They are supposed to take water from the bottom header upward to satisfy the uplift in the horizontal tubes 22.

The only tubes in Griffiths' boiler which the Commissioner finds comparable to the downcomers of the Murray application are those side wall tubes which are located nearest to the rear and the front of the boiler. That there should be a downflow through these is absurd. There are three of them at the back and two of them at the front, out of a total of thirty-one. Five tubes are to carry down enough water to supply twenty-six up-going tubes! Against the testimony of an expert that this won't work, the Commissioner's brief offers it as the only possible theory on which Griffiths' boiler will work.

The Commissioner's brief objects (pp. 6 and 7) to "appellant's theory of operation of Griffiths' boiler" because it is not a theory that is described in the Griffiths patent. True, it is only *a hint in the patent of the method of circulation.* There is no actual description.

But this lack of description should not work against appellant's claim. The same clear and specific disclosure in a prior patent is necessary to defeat a claim that is required in a later patent specification in order to sustain a claim thereon. The Commissioner cannot rely on such a theory as he presents, absolutely without foundation in the Griffiths patent, absolutely contrary to expert testimony and, we respectfully submit, most illogical.

5 (V) The Commissioner has cited the case of *Universal Arch Company* v. *American Arch Co.*, 290 Fed. Rep., 647, holding that no invention would result from the transfer of a brief [brick] baffle from a water tube boiler to a locomotive fire box, "unless some distinctly new function were performed or some new and useful result or advantage were achieved." This is to dispose of appellant's argument that the locomotive boiler of McClellon is not in point.

A reading of the opinion shows that the reservations and exceptions were more important than the general rule and that they amply justify appellant's argument that the use of tubes with fillers as they were arranged in the McClellon boiler constituted no helpful suggestion to Murray. The suit was brought on eleven patents relating to the shape and arrangement of bricks in the arches and walls of locomotive boilers. Brick arches and walls were old. The patents were for specific features. Baffles made of bricks were also old in water tube boilers.

In discussing the first patent, 904,494, which was based on an arch having its bricks supported in a certain way, the court found that the baffle bricks in prior patents for water tube boilers had been supported in the same way. The court held the patent anticipated because the arch of the patent in suit and the baffle wall of the prior water tube boilers were both "in the broad art of brick construction." *It was for that reason* that the court held the claim lacking in invention. And the court was careful to make certain reservations with respect to this same patent: that there is admittedly "a vast difference" between a baffling tile partition, which serves to conduct gases over the evaporating surfaces of the water tubes in a water tube boiler, and a refractory arch in the fire box of a locomotive (p. 649, l. 13). The court went further and held that invention would be involved if "some distinctly new function were performed, or some distinctively new and useful result or advantage were achieved."

The new function, result or advantage achieved by Murray's use of finned tubes, is in speeding the circulation which is the very life of a water tube boiler. In locomotive boilers there is no circulation, there is just a large vessel of water surrounding tubes through which the fire plays, and McClellon's finned tubes are merely separate parts of the vessel which are always filled with water and forming an integral part of the complete body of water being heated and boiled.

This situation brings us rather within the dictum of the court, in the above *Universal Arch* case as to the second patent. On page 649 this patent, 934,723, is said to refer to "separately and independently supported" bricks forming the arch. The court found that in the prior art relating to water tube boilers there was disclosure of bafiles in which the several bricks were separately and independently supported on the tubes. The locomotive boiler arch patent under consideration was nevertheless held valid, and the court concluded—

> "In the case of the Moore patent, 904,494, I was unable to find that any new function was performed or any new result was achieved by the use of a marginal brick in much the same manner in a locomotive arch as it had previously been used in a water tube boiler. But in the case of the Graham and German patent the record indicates that a different function was performed *and a new result achieved.* Consequently, it cannot be said that invention was not involved."

This is a very excellent distinction between the cases in which a patent may be defeated for anticipation by something found in another art and the cases in which it cannot be so defeated. The Murray case lies in the second category, in which invention is involved, because of the new result achieved, namely,—the circulation which is characteristic of water tube boilers.

b (~~a~~) While on the subject of the Commissioner's defense that Griffiths and McClellon together deprive Murray of any claim to patentable novelty, we submit that there is eloquent testimony to the contrary in his concluding sentence of the Commissioner's brief on this point (commencing last line, p. 9),—"It appears that appellant built a boiler with tubes for walls as disclosed by Griffiths and by McClellon and found that it worked notwithstanding the adverse opinions of the experts that holes would be burned in the tubes."

7 ([illegible]) On page 10 the Commissioner's brief asks "how cool are appellant's downcomer tubes?" They are cooler than those of Griffiths', no doubt. But this is not the sole question involved. The ultimate question which distinguishes Murray from Griffiths is,—will the water flow downward in Murray's downcomer tubes? The answer must be "Yes." We need only summarize here the three contributing causes to such downward circulation which we have discussed at length above.

(a) The water is already in movement downward in the downcomer headers of the boiler above.

(b) The side tubes are higher than the portion of the back tubes measuring from the bottom of the overhead boiler to the bottom header, and, therefore, the side tubes have a greater uplift.

(c) The baffles over head at the back, and the location of the grate in the front tend to make the back wall less hot than the side walls and the front wall.

8 ([illegible]) It is not fair to say, as the Commissioner's brief does on page 12, that there is no proof that the boiler of the Murray application made any more impression on the Boiler World than did the Griffiths patent. The Hell Gate boiler made an extraordinary impression. The boiler illustrated in the Murray application is not only the original design which eventuated into the Hell Gate boilers, but is in fact the same in all basic matters

as the Hell Gate boiler. The basic points are stated in the claims. The Commissioner does not question that these *claims read on the Hell Gate boiler as well as on the drawings of the patent application.*

9(k) The Commissioner returns again, on page 12 of his brief, to the Griffiths patent and draws an analogy between the statement of Mr. Lawrence that the Griffiths boiler won't work and the adverse opinion of experts that Murray's idea was not good. But the Commissioner's brief follows with an admission which we think goes to the very heart of the question of invention. He says:

> "Apparently it was not so much the concept of the idea of using a water wall in a furnace as it was Murray's determination to put it into use that made his wall in the Hell Gate Station a success."

This is based on the testimony showing that Mr. Murray went against the best judgment of a corps of experienced boiler men. They were known to him familiarly. He knew that they were well versed in all the conditions and requirements pertaining to these very boilers on which he was working. They were the designing and operating engineers of the company which employed Mr. Murray,—a company having probably the largest electrical system in the world. Mr. Murray was employed in a consultive capacity by the very company which was employing these engineers to maintain and use the furnaces that he was designing. These men were very familiar with boiler practice throughout the world and had had many years of experience in larger stations of the world. If it had been an obvious thing to install water walls in the furnaces, these men should have advocated such a construction instead of opposing the same.

The quality which history shows to have been predominant in the great inventors, is faith. Faith to perform what to dull clods seems like a miracle. Faith in the face of doubts among the wiseacres. Faith that nourishes persistence to overcome the obstacles interposed by doubters. This is the quality of Mr. Murray's work which made him a great inventor in several arts. This is the quality which contributed most strikingly to his development of modern large capacity boilers. The boiler of the present application is one of the foundation stones of such development and is worthy of the fullest protection.

Respectfully submitted,

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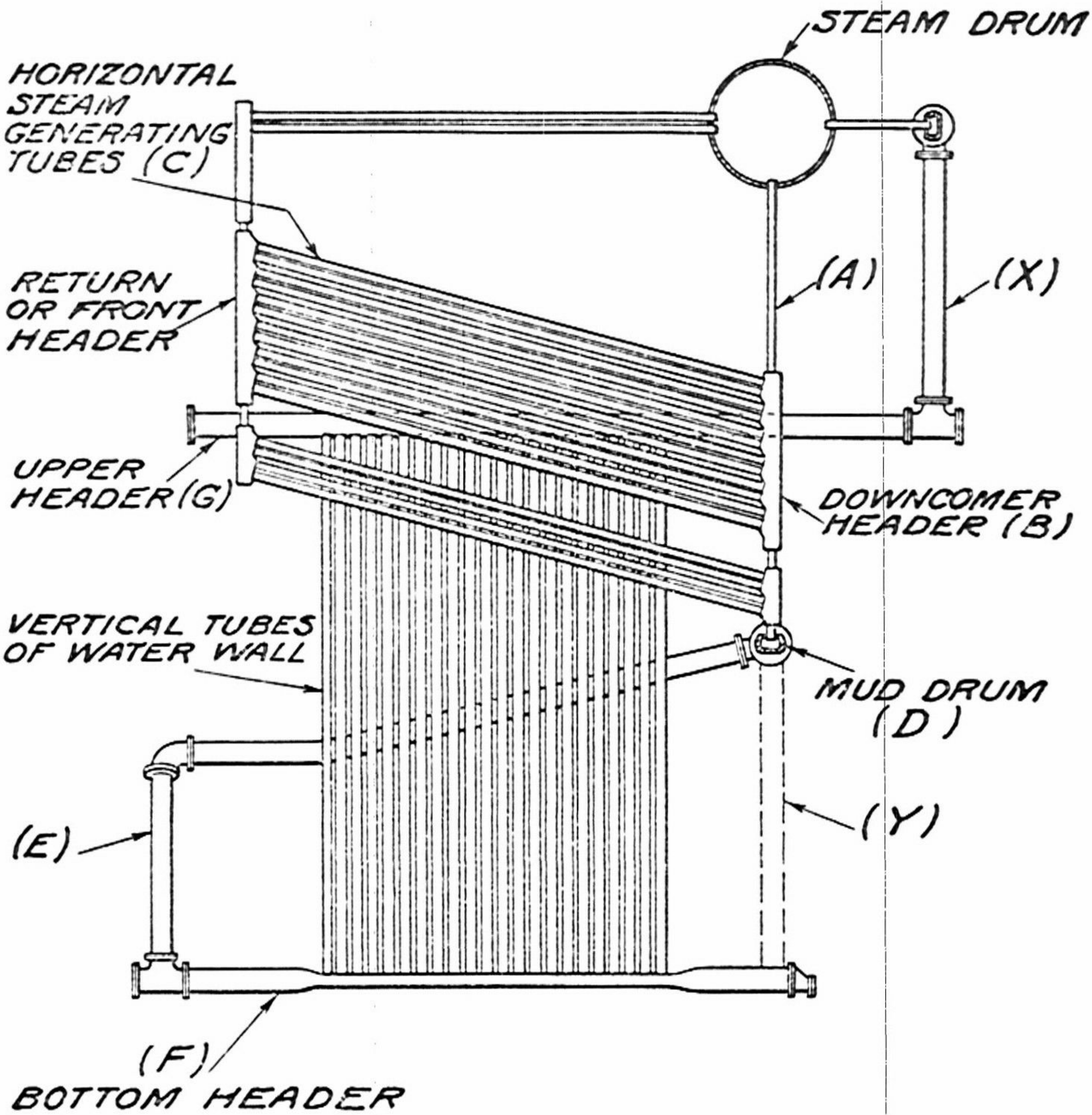
STEAM DRUM
HORIZONTAL STEAM GENERATING TUBES (C)
RETURN OR FRONT HEADER
(A)
(X)
UPPER HEADER (G)
DOWNCOMER HEADER (B)
VERTICAL TUBES OF WATER WALL
MUD DRUM (D)
(Y)
(E)
(F) BOTTOM HEADER

Motion for Leave to File Reply Brief for Appellant

United States Court of Appeals

For the District of Columbia

October Term, 1934

No. 6278

METROPOLITAN ENGINEERING COMPANY,
Appellant,

v.

CONWAY P. COE, Commissioner of Patents,
Appellee.

Appellant states that the brief for the Commissioner of Patents presents certain points of argument which are new and which could not fairly have been anticipated, and therefore

MOVES FOR LEAVE of the court to file the above reply brief.

MELVILLE CHURCH,
D. ANTHONY USINA,
C. B. DES JARDINS,
Counsel for Appellant.

WE CONSENT TO THE ABOVE MOTION.

....,
Solicitor for the Commissioner of Patents.